PPC-2000
User's Guide

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PPC-2000 Adaptive Control Addendum

Scope

This document describes the additional features and functionality found in the PPC-2010-xxB with adaptive control. Refer to the *PPC-2000 User's Guide* regarding all other functionality which is the same as the standard version.

Introduction

The Watlow Anafaze PPC-2000 controller offers these standard options:

- Forty-eight loops of conventional PID control with auto-tuning capability

  -or-

- Eight loops of adaptive control plus 24 loops of conventional PID control with auto-tuning for a total of 32 loops (the option described in this document)

ANAWIN3 HMI software is available to support either option. A mix of these options is not supported by ANAWIN3.

ANAWIN3 Software Installation

Follow the standard instructions to install and setup ANAWIN3. In the setup program select the *Adaptive Control* option.

Spreadsheet Overview Screen

Several new parameters and options appear on the Spreadsheet Overview screen in support of the adaptive control option. These parameters and options are applicable only for the first eight channels and are omitted or ignored for channels 9 to 32.

Control Type

An additional option appears for *Control Type*. Select *Adaptive* to enable adaptive control and tuning on a channel. This option is only valid for channels 1 to 8.
Values: PID1 (0), PID2 (1), Adaptive (2) and Retransmit (3)
Default: PID1 (0)
Modbus Address (Channels 1 to 32): 46401 to 46432
Parameter Number: 19
LogicPro Driver: Database
LogicPro Address (Channels 1 to 32): 19.1 to 19.32

Adaptive Mode

When *Control Type* is set to *Adaptive*, this parameter can be used to pause tuning or to reset the adaptive algorithm and have it relearn the system. This parameter has no effect on control if the *Control Type* for the loop is set to an option other than *Adaptive*.
Values: Adapt (0), Reset (1) and Hold (2)
Default: Reset (1)
Modbus Address (Channels 1 to 32): 49001 to 49032
Parameter Number: 21
LogicPro Driver: Database
LogicPro Address (Channels 1 to 32): 21.1 to 21.32

Table 1. Adaptive Mode Settings

Setting	Description
Adapt	The normal setting for a loop with *Control Type* set to *Adaptive*. The loop is adapting and tuning while controlling.
Reset	Select this option to have the control loop start from scratch and relearn the load characteristics. The *Control Mode* must be set to *Off* or *Manual* to select this option for an adaptive loop. This is the normal setting for a loop with *Control Type* set to a value other than *Adaptive*.
Hold	Select this option to have the control loop stop learning temporarily but retain the learned load characteristics. For example in the event that maintenance will be performed, it may be advantageous to pause adapting to avoid false data being introduced. Select this option anytime you want the controller to stop adapting and continue to control with the parameters learned up to that point.

Plant Delay

This parameter indicates the amount of delay in seconds in the load. This characteristic of the load or plant has a significant impact on adaptive control. A larger number indicates a longer delay between, for example an increase in heater power and an increase in the temperature.

Choose *Automatic* and then set the *Control Mode* to *Auto* to have the adaptive algorithm determine the plant delay for the loop. The loop must be at least 40 degrees below set point and the controller must observe a temperature change of at least 20 degrees to determine the *Plant Delay*. If you have determined the *Plant Delay* with the PPC-2000's adaptive control previously and found the performance acceptable, you may choose the delay directly and the loop will use the value you choose rather than measure it.

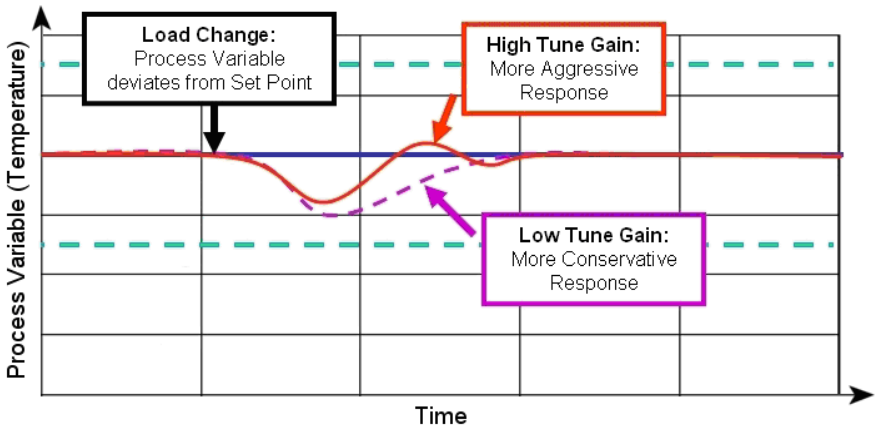
This setting is not reset by the *Adaptive Mode* parameter's *Reset* option. To have the controller relearn the *Plant Delay*, set the loop's *Control Mode* to *Manual* or *Off*, set the *Plant Delay* to *Automatic*, and then set the *Control Mode* to *Auto* again.

This parameter has no effect on control if the *Control Type* for the loop is set to an option other than *Adaptive*.
Values: Automatic (0) and 1 (1) to 600 seconds (600)
Default: Automatic (0)
Modbus Address (Channels 1 to 32): 49051 to 49082
Parameter Number: 28
LogicPro Driver: Database
LogicPro Address (Channels 1 to 32): 28.1 to 28.32

Tuning Gain

This parameter indicates the amount of delay in seconds in the load. This characteristic of the load or plant has a significant impact on adaptive control. A larger number indicates a longer delay between, for example an increase in heater power and an increase in the temperature.
Values: Aggressive (0), Nominal (1), Damped 1 (2), Damped 2 (3), Damped 3 (4) and Damped 4 (5)
Default: Nominal (1)
Modbus Address (Channels 1 to 32): 46551 to 46682
Parameter Number: 29
LogicPro Driver: Database
LogicPro Address (Channels 1 to 32): 29.1 to 29.32

Figure 1. The Effect of Tuning Gain on Recovery from a Load Change



Using Adaptive Control

To set up adaptive control on one or more channels:

1. Open the **Spreadsheet Overview** screen in ANAWIN3.
2. On the **Inputs** spreadsheet for each analog input you have wired:
   a. Choose the appropriate **Input Type** for the sensor.
   b. Choose **Units**.
   c. For any linear voltage, current, or pulse sensors, set the linear scaling parameters (**Input Signal Lo, Input Signal Hi, PV Lo,** and **PV Hi**). See *Setting up User Selectable Linear Inputs* on page 98 of the *PPC-2000 User's Guide*.
3. On the **Channels** spreadsheet for each channel:

a. In the **PV Source** field, choose the input that you want to monitor or use as feedback for closed-loop control.

b. In the **Heat Output Dest** and/or **Cool Output Dest** fields, choose the outputs that you want to use for closed-loop control.

c. Choose a **Heat/Cool Output Type** for each output.

d. Set the **Heat/Cool Cycle Time** for any outputs with **Heat/ Cool Output Type** set to **Time Prop**.

4. On the **Digital I/O** spreadsheet:

   a. Set the **Direction** for each I/O point to be used for control to **Output**.

5. On the **Channels** spreadsheet:

   a. For channels other than the adaptive ones, if both heat and cool outputs are used, set the **Spread**.

   b. For each channel that will perform adaptive control, for the **Control Type**, choose **Adaptive**.

   c. Set the **Set Point** to the desired value at least 40 engineering units (typically degrees) above the process variable.

   d. Set the **Control Mode** to **Auto** to begin adaptive closed-loop control.

NOTE: Only channels 1 to 8 can be selected for adaptive control.

PPC-2000 User's Guide Addendum

Overview

This document contains additional specifications for the PPC-2000 system.

Environmental Specifications

Table 1 here contains specifications in addition to those found in tables 7.4, 7.15, 7.23, 7.31, 7.39, 7.46, 7.52, 7.57, 7.62, 7.67 in the PPC-2000 User's Guide.

TABLE 1. Environmental Specifications

Altitude	2000 meters max
Non-Condensing Humidity	10 to 95%
Relative Humidity	80% max (ambient temperature <= 31° C) 50% max (ambient temperature = 40° C)
Pollution Category	Degree 2 (per IEC 664)
Operating Temperature Range	0 to 60° C (32 to140° F)
Storage Temperature Range	-20 to 70° C (-4 to 158° F)

PPC IPS International Power Supply Specifications

Table 2 here contains specifications in addition to those found in table 7.75 in the PPC-2000 User's Guide.

TABLE 2. Power Specifications

Input (Mains Supply)	88 to 132 Vac (120 Vac nominal) 176 to 264 Vac (240 Vac nominal)
Voltage Fluctuation	< +10% of nominal voltage
Transient Over-Voltage	Category II per IEC 664
Output	V1: +5 Vdc @ 6 A V2: +24 Vdc @ 4 A
Input Frequency	47 to 440 Hz
Peak Current Output	9A @ 5Vdc 6A @ 24 Vdc

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Please Note: External safety devices must be used with this equipment.

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1

Overview

Manual Contents

This manual describes how to install, set up, and operate a PPC-2000 controller. Each chapter covers a different aspect of your control system and may apply to different users. The following describes each chapter's purpose.

- **Chapter 1: Overview.** Provides component list and summary of features for the PPC-2000.
- **Chapter 2: Hardware Installation.** Provides detailed instructions on installing the PPC-2000 system and its peripherals.
- **Chapter 3: Software Setup.** Describes how to use your PPC system with *AnaWin3*, the Watlow Anafaze Human-Machine Interface (HMI) software.
- **Chapter 4: Troubleshooting.** Includes troubleshooting, upgrading and reconfiguring procedures for technical personnel.
- **Chapter 5: Custom Interfacing.** Provides information on setting up third-party software or an operator interface terminal for operating and monitoring a PPC System. Also provides information needed to address parameters when writing programs using *LogicPro*.
- **Chapter 6: Tuning and Control.** Describes available control algorithms and provides suggestions for applications.
- **Chapter 7: Specifications.** Lists detailed specifications of the controller and optional components.

Getting Started

The following sections provide information regarding product features, system components, safety requirements, and preparation for operation.

Safety symbols

These symbols are used throughout this manual:

WARNING! ***Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

CAUTION! ***Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury or property damage.***

NOTE! ***Indicates pertinent information or an item that may be useful to document or label for later reference.***

Contacting Watlow Anafaze

To contact Watlow Anafaze, send correspondence to:

Watlow Anafaze, Inc.
314 Westridge Drive
Watsonville, CA 95076

Our technical support and customer service departments may be reached Monday-Friday, 8 a.m. to 5 p.m. Pacific time:

Telephone: +1 (831) 724-3800
Email: anafazetechsupport@watlow.com

Be sure to specify *PPC2000* when asking for technical support.

Initial Inspection

Accessories may or may not be shipped in the same container as the PPC-2010 controller, depending upon their size. Check the shipping invoice carefully against the contents received in all boxes.

Product Features

The PPC-2000 (PPC) offers high performance closed-loop (PID) control and the ability to manipulate process control algorithms and sequential logic in a very user friendly way. It is a modular programmable process control system that utilizes plug-in modules to meet different system requirements. The controller can be configured for as many as 48 channels of PID control and supports up to 288 programmable digital I/O points. A motor interface module allows for operating up to 16 motor speed control systems. Seven types of hardware modules are supported by the PPC system. *AnaWin3* HMI software is used for configuration, operation and data acquisition. *LogicPro* software is available as an option and can be used to write logic programs for sequential and process control.

The PPC controller includes the following features:

- Multiple channels of closed-loop control and programmable logic in an integrated package
- User-programmable, advanced control algorithms
- Modular hardware
- Bus expansion up to 9 additional modules
- Serial communication
- *AnaWin3* operator interface compatible (single or multiple PPC modbus network capability
- Analog inputs (as many as 128) per PPC system
- Multiple sensor inputs: multiple TC types, RTD, voltage, current
- As many as 288 digital I/O points
- 48 closed-loop control channels with autotune
- Windows®-based logic programming software (option)
- Third-party operator interface terminal (OIT) support (option)

System Components

Any system must include a power supply and a processor module (PPC-2010) with built-in digital I/O. The appropriate additional modules are added for analog inputs, analog outputs, and expanding the digital I/O.

See *Figure 1.1 on page 6-4* and *Figure 1.2 on page 6-6* for illustrations of the PPC's system components and modules. Refer to *Table 1.1 on page 5* for a description of the modules and their functions.

The number and types of I/O are determined by which modules are selected for the application. Field wiring connects to DIN rail or panel mounted terminal block boards. Terminal block boards connect to I/O modules via 50-pin SCSI cables.

The following hardware and software interfaces are provided:

Hardware

- Serial ports for interfacing host computers and third-party operator displays
- Analog input and output terminal block connections
- Digital input and output terminal block connections

Software / Firmware

- Remote third-party operator interface panel software using Modbus protocol (option)
- AnaWin3 Configurator edition: Windows configuration utility
- LogicPro: Windows logic programming utility (option)
- AnaWin3 Developer edition: Windows user interface, data monitoring and trend logging utility (option)

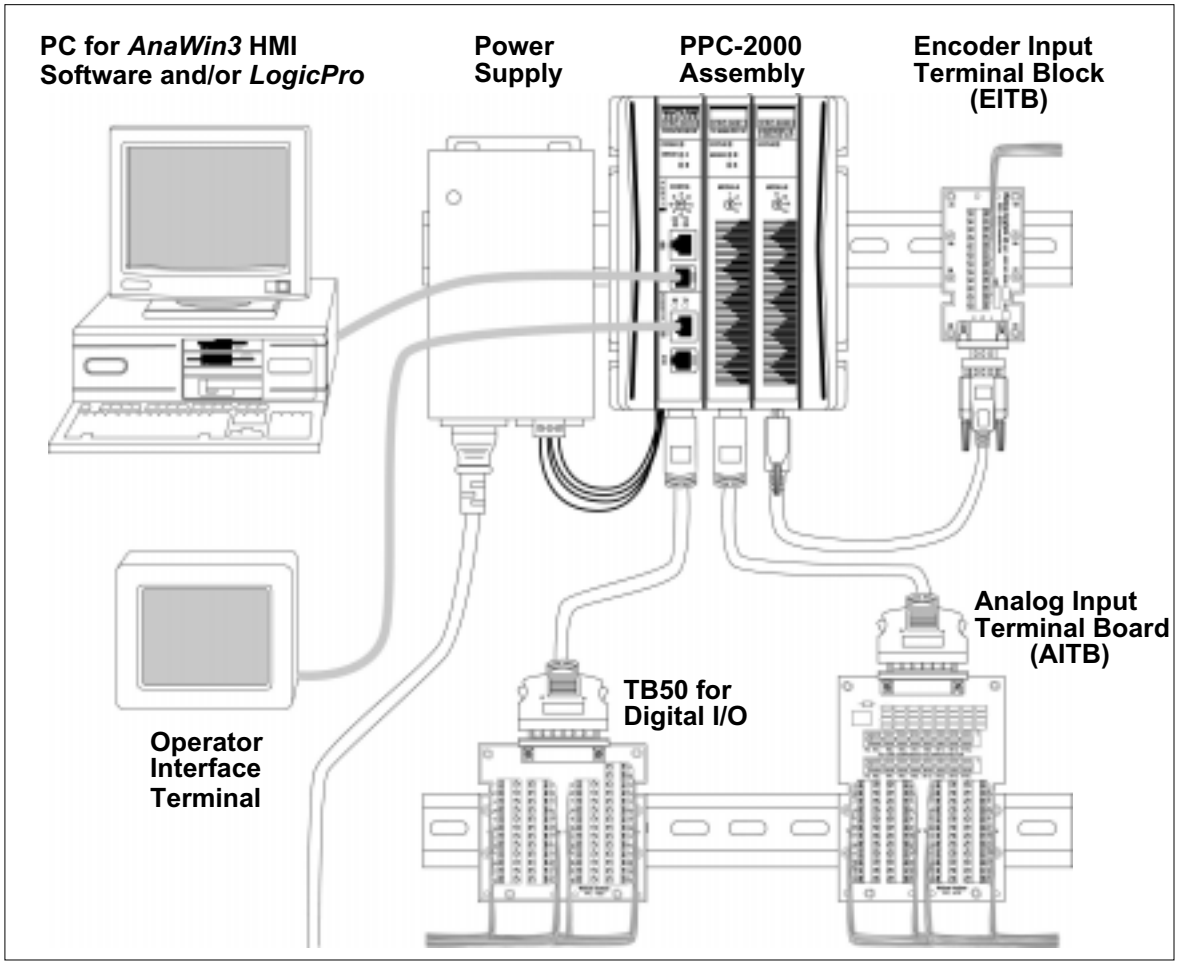

PC for *AnaWin3* HMI Software and/or *LogicPro*
Power Supply
PPC-2000 Assembly
Encoder Input Terminal Block (EITB)
Analog Input Terminal Board (AITB)
TB50 for Digital I/O
Operator Interface Terminal

Figure 1.1 System Diagram

Table 1.1 PPC-2000 System Modules

Module	Description
PPC-2010	Processor, 48 digital I/O, 2 serial ports, 1 counter/frequency input
PPC-2021, 2022	16 differential or 32 single-ended analog inputs
PPC-2024, 2025	8 or 16 highly isolated analog inputs
PPC-2030	4 encoder inputs and 4 analog outputs
PPC-2040	32 configurable digital I/O, 2 counter/frequency inputs
PPC-2050	8 analog outputs
PPC-2051	4 analog outputs
PPC-2061	16 relay outputs
PPC-2062	8 relay outputs
PPC-2070, 2071	8,16 120Vac inputs
PPC-2072, 2073	8,16 24V AC/DC inputs

Table 1.2 PPC-2000 Terminal Boards and Peripheral Modules

Terminal Board	Description
PPC-IPS-2	International Power Supply, 120W
PPC-AITB-1	Analog Input Terminal Board
PPC-TB50-SCSI	Terminal board for digital I/O
PPC-EITB-1	Encoder Input Terminal Board

Table 1.3 Analog Terminal Board Keys

Key (Color Code)	Descriptions
PPC-KEY-20 (none)	Adapts AITB for: Thermocouples (differential or single-ended) Linear voltages (differential or single-ended)
PPC-KEY-30 (blue)	Adapts AITB for 0-20mA linear current (differential)
PPC-KEY-40 (black)	Adapts AITB for 0-20mA linear current (single-ended)
PPC-KEY-50 (red)	Adapts AITB for 2-wire RTDs (differential) or 3-wire RTDs (differential)

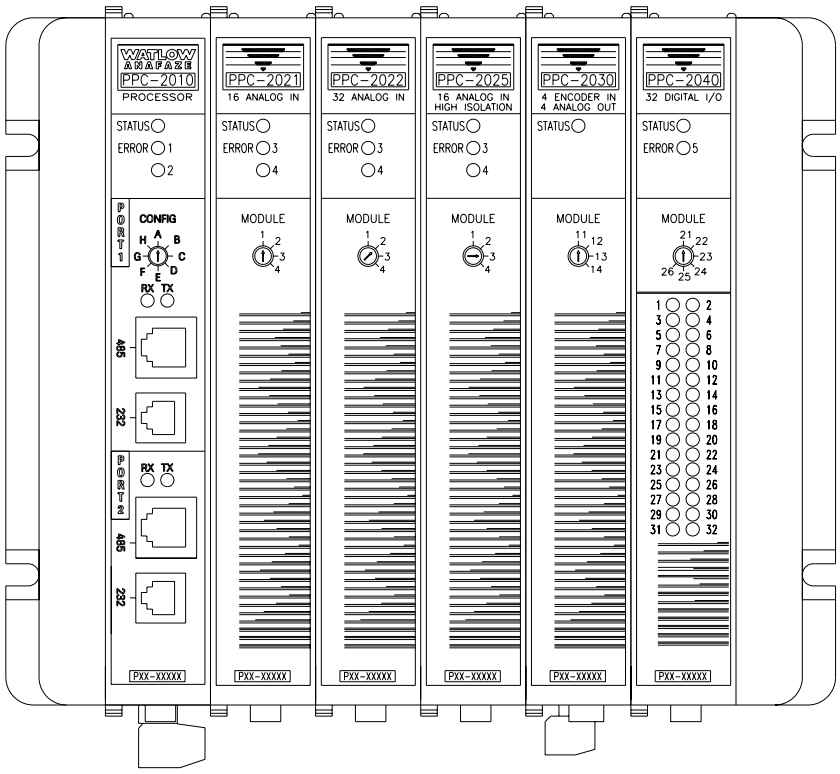


Figure 1.2 Sample PPC-2000 System

PPC-2000 Modules

The following sections describe the purpose and features of each type of module available with the PPC-2000 system.

PPC-2010 Processor Module

The PPC-2010 processor module houses the system microprocessor, memory and controller programs. Modular communication ports support connections with a PC running *AnaWin3* and *LogicPro* or third-party interface software, and connections with third-party operator interface panels or other devices that communicate using Modbus protocol. Communications ports one and two may be used simultaneously.

Additional modules may be connected to the processor module's expansion bus to add capabilities to the PPC system.

Precision analog outputs can be provided using Serial Digital to Analog Converters (SDAC). Each SDAC unit converts a control output from the processor module to an analog voltage or current signal. For more specific information, see *SDAC Serial Analog-to-Digital Converter on page 9*.

The PPC-2010 has 48 built-in digital I/O points. 24 points are outputs only. 22 of these outputs are user configurable for PID control, alarms or logic outputs. The other 2 outputs are dedicated to system status and global alarm. The remaining 24 I/O points are individually configurable as either inputs or outputs.

The following summarizes the processor's features:

- 2 isolated communication ports
- Transmit/receive indicators
- Rotary switch for setting the Modbus network address
- 46 user configurable digital I/O
- System status and digital output overload indicators
- Real time clock
- Flash PROM and battery backed RAM
- Connects to terminal block board via 50-pin SCSI cable

PPC-2021 - 2022 Analog In Modules

The PPC-2021 and 2022 modules plug in to the module expansion bus. The analog input modules support 16 differential inputs or 32 single-ended inputs, and accommodate various sensors such as thermocouples (TCs), Resistive Temperature Sensing Devices (RTDs) and linear transducers using the terminal boards described later in this section.

- Supports TCs, RTDs and linear voltage and current signals
- LED status indicator
- DIN rail/panel mount
- Connects to analog input terminal board via 50-pin SCSI cable

PPC-2024 - 2025 Analog In High Isolation Modules

The PPC-2024 and 2025 modules plug in to the module expansion bus. The high isolation analog input modules accept 8 or 16 differential analog inputs and accommodate various sensors such as TCs, RTDs and linear transducers using the terminal boards described later in this section.

- High voltage isolation capability
- Supports TCs, RTDs and linear voltage & current signals
- LED status indicator
- DIN rail/panel mount
- Connects to analog input terminal board via 50-pin SCSI cable

PPC-2030 Encoder In Analog Out Module

The PPC-2030 is used in applications including monitoring and controlling belt speeds, motor speeds, positioning, etc.

Four isolated analog outputs are jumper configurable for current or voltage. These outputs may be used to provide software selectable analog output signals to field devices.

Four counter inputs are used for interfacing to motor encoder signals. The counters interface to both single-ended and differential styles of encoder signals and count quadrature signals for increased resolution, accuracy and direction.

PPC-2040 Digital I/O Module

Up to four PPC-2040 modules may be added to a PPC system. Each module includes 32 digital I/O points which are individually configurable as inputs or outputs and two counter and frequency inputs.

PPC-2050 - 2051 Analog Out Modules

Up to four PPC-2050 and PPC-2051 modules may be added to a PPC system. Modules include four or eight analog outputs.

PPC-2061 - 2062 Digital Out Relays Module

Up to six PPC-2060, PPC-2061, and PPC-2062 modules may be added to a PPC system. The PPC-2061 features 16 electromechanical relays. These relays can switch AC or DC loads. Two sets of eight relays each have a common. The PPC-2062 features eight electromechanical relays.

PPC-2070 - 2073 Digital In Modules

Up to four modules of this type may be added to a PPC system. Each module includes either 8 or 16 discrete inputs. The PPC-2070 and 2071 modules accept 120Vac signals. The PPC-2072 and 2073 modules accept either 24Vac or 24Vdc.

PPC-2000 Terminal Boards

The following sections describe the terminal boards that support field I/O connections to some modules.

PPC-AITB-1 Analog Input Terminal Board

The AITB is a compact field wiring interface for all analog input modules. The AITB includes terminal blocks and removable keys used for different types of inputs such as TCs, RTDs and linear signals. For more information on these signals, refer to PPC-KEY-01 through 04 in *Table 1.1 on page 5*. The keys allow easy configuration of the terminal block for different types of inputs on different channels. The AITB is DIN rail or panel mount compatible.

PPC-EITB-1 Encoder Input Terminal Board

The EITB is a DIN rail or panel mountable terminal block card which provides means to interface with motor encoders. Two pulse inputs (single ended or differential, single or quadrature phased) may be connected to the screw terminals. A 5Vdc power source interconnect is provided to supply encoders.

PPC-TB50-SCSI 50-Pin Terminal Board

The TB50 connects to the Processor or Digital I/O module through the SCSI connector. The terminal blocks interface to digital I/O field wiring (sensors, actuators, relays, SSRs, etc.). The TB50 has 48 input/output points. This terminal board is DIN rail or panel mount compatible.

Additional Components

The following sections describe the optional SDAC module and the PPC-IPS-2 power supply.

SDAC Serial Analog-to-Digital Converter

The SDAC peripheral module can be connected to a digital output on the PPC-2010 Processor module. The SDAC converts a special serial signal to an analog output.

One digital output is required for each SDAC module. Up to 5 SDACS may be connected. When using one or more SDACs, the SDAC clock output from the PPC-2010 is used as well. The Processor/SDAC clocks are tied together (the same clock line is used for each SDAC).

PPC-IPS-2

The PPC-IPS-2 accepts power in two switch-selectable ranges: 88 to 132Vac and 176 to 264Vac at 47 to 440Hz. It has overload and overvolt protection. The PPC-IPS-2 powers the PPC system with 24Vdc and has 5Vdc available for powering loads.

Safety

Watlow Anafaze has made every effort to ensure the reliability and safety of this product. In addition, we have provided recommendations that will allow you to safely install and maintain this controller. This product should not be used in any manner not specified by Watlow Anafaze.

WARNING! ***Ensure that power has been shut off to your entire process before you begin installation or servicing of the controller.***

WARNING! ***Power, input or output circuits with hazardous voltage levels should not have any live accessible parts.***

WARNING! ***In any application, failures can occur. These failures can result in full control output (100% power), or the occurrence of other output failures which can cause damage to the controller, or to the equipment or process connected to the controller. Therefore, always follow good engineering practices, electrical codes, and insurance regulations when installing and operating this equipment.***

CAUTION: This product is intended for indoor use only.

External Safety Devices

External safety devices should be used to prevent potentially dangerous and unsafe conditions upon equipment failure. Always assume that this device can fail with outputs full-on, or full-off, by the occurrence of an unexpected external condition.

WARNING! ***Always install high or low temperature protection in installations where an over-temperature or under-temperature fault will present a potential hazard. Failure to install external protection devices where hazards exist can result in damage to equipment and property as well as loss of human life.***

Contact Watlow Anafaze immediately if you have any questions about system safety or system operation.

External Switch Disconnect

WARNING! ***Provide a labeled switch or circuit breaker connected to the PPC-2000 power wiring as the means of disconnection for servicing. Failure to do so could result in damage to equipment and/or property, and/or injury or death to personnel. The disconnect should be located so that operators and technicians can access it quickly and easily.***

Battery Safety

CAUTION! ***The battery used in this device may result in a fire or chemical burn hazard if mistreated. Do not disassemble, heat above 100˚C (212˚F) or incinerate. Dispose of used battery properly. Keep away from children.***

Product Markings and Symbols

CE — This symbol indicates that the products meets the essential requirements of applicable European Union Directives.

c UL US LISTED — This symbol indicates that the product is listed by Underwriters Laboratory and Canadian Underwriters Laboratory.

⎓ — The terminals adjacent to this symbol should be connected to DC voltage only.

2

Hardware Installation

This section describes how to install your PPC system hardware. It provides detailed instructions for each component and peripheral item. Read this chapter before installing your PPC-2000 system.

Power Supply Requirements

Watlow Anafaze provides the PPC-IPS2 power supply for the PPC-2000 system. This unit supplies sufficient current for a processor and various combinations of I/O modules. For specification information on the power supply, refer to *Chapter 7, Specifications*.

Any power supply connected to the PPC-2000 should meet these requirements:

- Transformer isolation
- Reliable operation without noise or feedback
- Provides specified voltage and current
- UL Listed
- Suitable for use in a 60°C ambient environment

Regardless of which power supply you use, you must provide sufficient current in the specified voltage range, 10-28Vdc. The current requirement depends on the type and number of modules used. A separate power supply is required for each controller. Use *Table 2.1 on page 14* to calculate the current requirements for your system.

Table 2.1 Power Supply Current Requirements at 12Vdc

Module	Number of modules		Current (startup) per module		Current
PPC-2010	1	x	250mA	=	250mA
PPC-202x (max. 4)		x	390mA	=	
PPC-2030 (max. 4)		x	900mA	=	
PPC-2040 (max. 6)		x	300mA	=	
PPC-2050 PPC-2051 (max. 4)		x x	800mA 500mA	= =	
PPC-206x (max. 6)		x	250mA	=	
PPC-207x (max. 4)		x	100mA	=	
Total Number of Modules (max. 10)			total current required	=	

Table 2.2 Power Supply Current Requirements at 24Vdc

Module	Number of modules		Current (startup) per module		Current
PPC-2010	1	x	125mA	=	125mA
PPC-202x (max. 4)		x	195mA	=	
PPC-2030 (max. 4)		x	450mA	=	
PPC-2040 (max. 6)		x	150mA	=	
PPC-2050 PPC-2051 (max. 4)		x	400mA 250mA	=	
PPC-206x (max. 6)		x	125mA	=	
PPC-207x (max. 4)		x	50mA	=	
Total Number of Modules (max. 10)			total current required	=	

WARNING! ***The PPC is designed to operate on 12-28Vdc. Connection to a power source other than this will cause damage to the PPC.***

To avoid electrical shock, correctly connect the power supply's earth ground.

Mounting the Power Supply

Mount the hardware in an area free of moisture or corrosive chemicals. Mount the power supply vertically with adequate vent space. Locate the power supply for the PPC such that the AC supply and DC connections to the PPC may be made. The PPC-IPS-2 can be DIN rail or screw mounted. Refer to *Figure 2.1* for power supply mounting clearances. All dimensions are measured in inches.

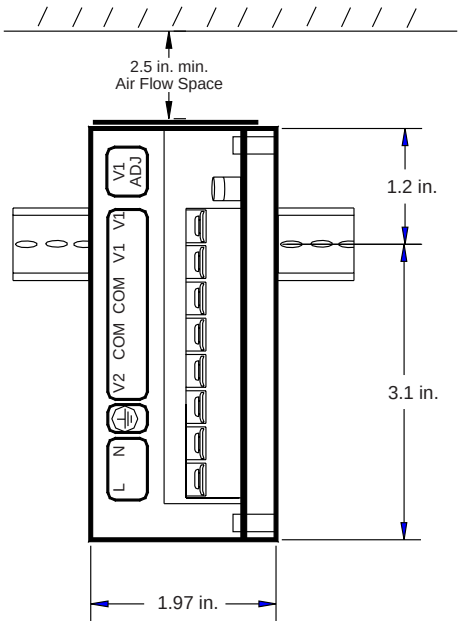


Figure 2.1 PPC-IPS-2 DIN Mounting Dimensions

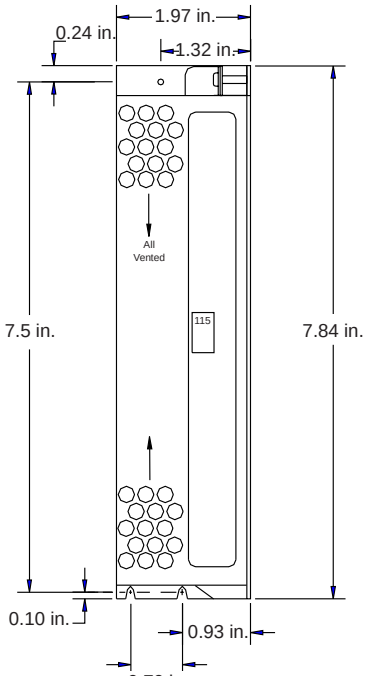


Figure 2.2 PPC-IPS-2 Panel Mounting Dimensions

To DIN rail mount the PPC-IPS-2:

1. Locate a space with sufficient room for the power supply and connecting wires. Refer to *Figure 2.1 on page 15*.
2. Install a section of DIN rail.
3. Hook the top of the DIN rail latch over the DIN rail such that the spring is under the lip of the rail.
4. Push down on the power supply, compressing the spring then rock the bottom of the latch onto the rail.

To panel mount the PPC-IPS-2:

1. Locate a space with sufficient room for the power supply and connecting wires. Refer to *Figure 2.2*.
2. Mark the mounting holes. See *Table 2.3 on page 16*.
3. Drill and tap the mounting holes.
4. Place the power supply such that the holes are aligned, insert the screws and tighten them

Table 2.3 Power Supply Screw Mounting

	PPC-IPS-2
Number of Screws	3
Drill and tap size	#6

Hardware Configuration

In order for multiple PPC modules to function together, each needs to be addressed correctly. Some of the PPC modules may require jumper or switch settings to work with field input and output devices. The following sections describe the configuration options and procedures.

Module Addresses

Each module in a PPC assembly must have a unique address. The PPC-2010 module is fixed as module address 0 in the firmware. The other modules' addresses are set with rotary switches on the face of each module. Set a unique address on each module by turning the arrow to an appropriate address number. See *Figure 2.3*.

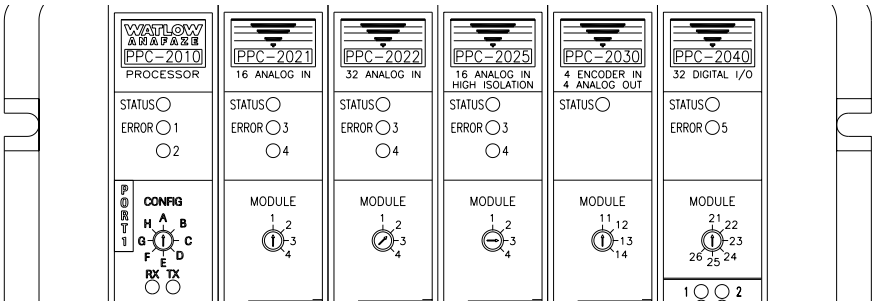


Figure 2.3 Sample Addresses

Table 2.4 on page 18 lists the maximum number allowable of each type of module per system, as well as the available address settings. Pay close attention when using more than one module of a particular type in a system. For example, one PPC system allows up to four analog input modules (PPC-2021 - 2025) and each must have a unique address setting, as shown in *Figure 2.3*.

CAUTION! ***If address settings are changes, modules added or removed after the system has been initialized, modules may not function correctly. To assure proper operation, perform a RAM Clear after changing the number of modules or address settings in a PPC system. Refer to Chapter 4, Resetting Closed-Loop Control Parameters on page 156.***

NOTE! ***It may be useful to label each module with the address you select.***

Table 2.4 System Modules and Addressing

Module	Max. #*	Rotary Switch Address Range
2010 (PROCESSOR)	1	0 (not switch selectable)
2021, 2022 (ANALOG IN) 2023, 2024, 2025 (ANALOG IN HIGH ISOLATION)	4	1-4
2030 (ENCODER IN ANALOG OUT)	4	11-14
2040 (DIGITAL I/O)	6	21-26,
2050, 2051 (ANALOG OUT)	4	31-34
2061, 2062 (DIGITAL OUT)	6	41-46
2070, 2071 (DIGITAL IN, 120Vac) 2072, 2073 (DIGITAL IN, 24Vac/DC)	4	51-54

* *Maximum number of this type of module in a system*

PPC-2010 Jumper Settings

Jumper settings in the PPC-2010 select whether the communication lines are terminated or not. Each communication port is configured separately. For installation information, refer to Connecting RS-485 Communications on page 81.

Wear a grounding strap and place components on static-free grounded surfaces only. Locate jumpers 1 and 2. *Table 2.5* describes the PPC-2010 jumper configuration. Install the jumper in the orientation shown in *Figure 2.4 on page 19*.

Table 2.5 PPC-2010 Processor Module Jumpers

Port	Jumper #	Terminated Position	Unterminated Position
1	JU1	A	B
2	JU2	A	B

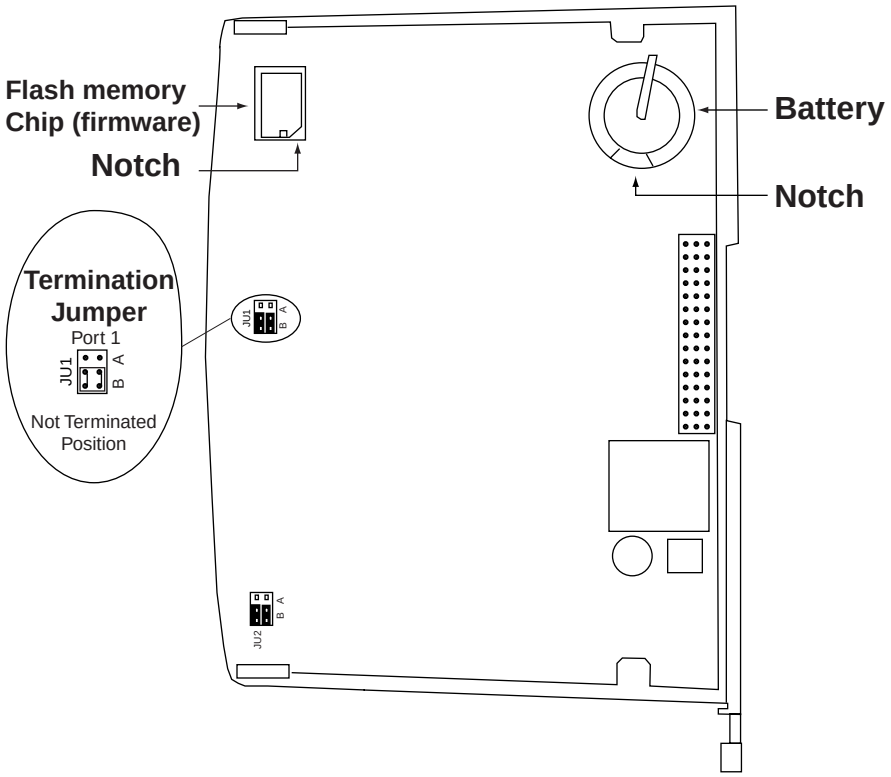


Figure 2.4 PPC-2010 Jumpers

PPC-2030 Dip Switch Settings

Switch settings in the PPC-2030 determine whether encoder inputs accept single phase or quadrature encoder signals. Each of the four inputs is configured individually, therefore single phase and quadrature inputs may be mixed in a module.

Wear a grounding strap and place components on static-free grounded surfaces only. Locate switch bank 1 near the center of the PPC-2030 module. Refer to *Figure 2.5 on page 20.* Set each switch for the corresponding input to the single phase (on) or quadrature (off) position. The switch is on when in the direction indicated by the arrow.

CAUTION! ***Be sure to take antistatic precautions.***

{Improve illustration. More like 2.6 and 2.7.}

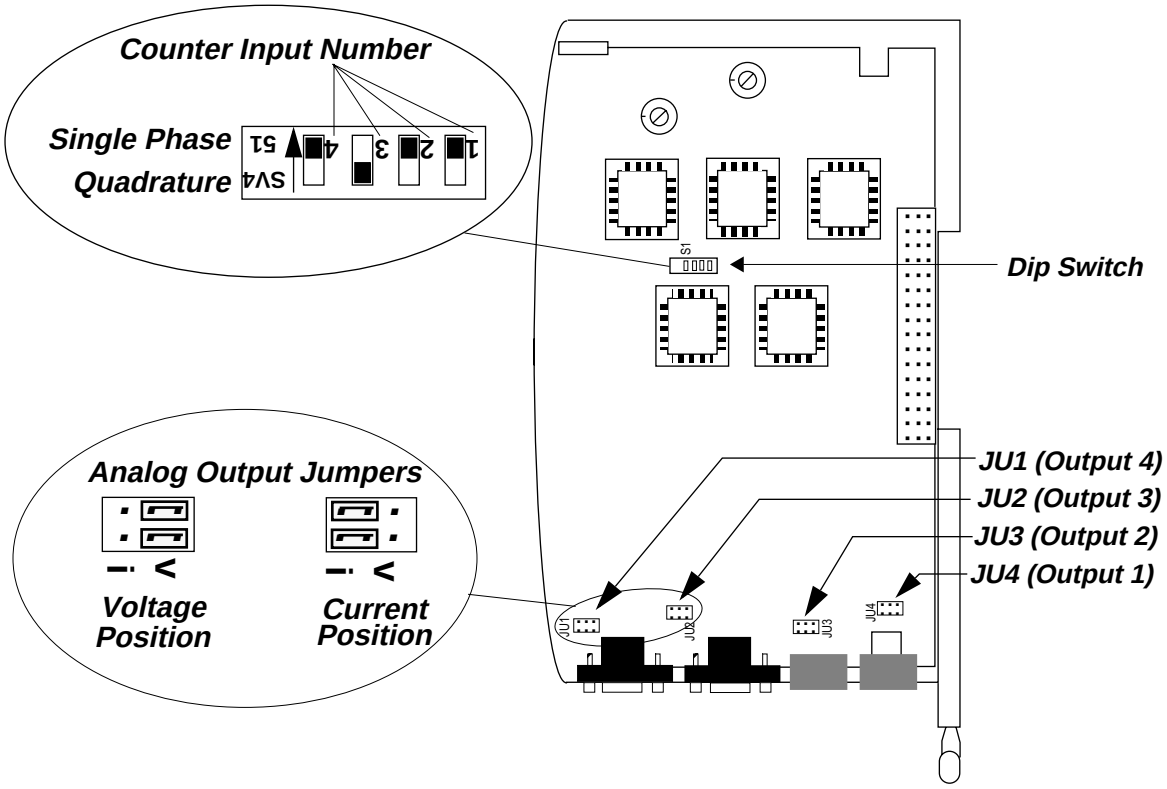


Figure 2.5 PPC-2030 Jumpers and Switches

PPC-2030 Jumper Settings

Each of the four analog outputs on the PPC-2030 may be configured either as a voltage output or a current output. A mixture of current and voltage outputs may be used on a particular module. The jumpers only determine if the output signal is current or voltage. The actual span of the signal is software selectable. See *Output Type* in *Channels on page 115* for the various analog output signal settings.

Locate Jumpers 1 through 4. *Table 2.6 on page 21* describes the analog output jumper configuration. Install the jumper in the orientation shown in *Figure 2.5*.

CAUTION! ***Incorrectly installing the jumper may damage the PPC-2030 module.***

Table 2.6 PPC-2030 Analog Output Jumpers

Analog Output	Jumper #	i (current) position*	V (volt) position*
1	JU4	0-20mA	0-10Vdc
2	JU3	0-20mA	0-10Vdc
3	JU2	0-20mA	0-10Vdc
4	JU1	0-20mA	0-10Vdc

** Listed values are maximum ranges. Other ranges within these limits may be selected in software.*

PPC-2040 Jumper Settings

Each of the counter inputs on the PPC-2040 can be configured for single phase or quadrature input. Jumper positions determine the counter input configuration. To select single phase or quadrature, see *Table 2.7* and *Figure 2.6* to determine which jumper to set and appropriate position.

Table 2.7 PPC-2040 Counter Input Jumpers

Counter Input	Jumper PPC-2040	Single Phase Position	Quadrature Position
1	JU1	A	B
2	JU2	A	B

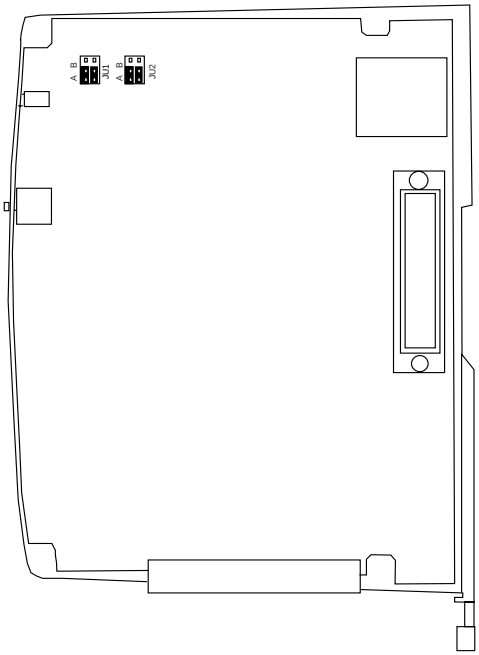


Figure 2.6 PPC-2040 Jumper Settings

PPC-205x Jumper Settings

Each of the analog outputs on the PPC-205x modules may be configured either as a voltage output or a current output. A mixture of current and voltage outputs may be used on a particular module. The jumpers only determine if the output signal is current or voltage. The actual span of the signal is software selectable. See *Heat/Cool Output Type* in *Channels* section on *page 119* for the various analog output signal settings.

To configure an output, see *Table 2.8 on page 22* and *Figure 2.7 on page 23* to determine which jumper to set. Set the jumper in the indicated position and orientation.

Table 2.8 PPC-205x Analog Out Jumpers

Analog Output	Jumper PPC-2050	Jumper PPC-2051	i (current) Position*	v (voltage) Position*
1	JU1	JU1	0-20mA	0-10Vdc
2	JU2	JU3	0-20mA	0-10Vdc
3	JU3	JU5	0-20mA	0-10Vdc
4	JU4	JU7	0-20mA	0-10Vdc
5	JU5	n/a	0-20mA	0-10Vdc
6	JU6	n/a	0-20mA	0-10Vdc
7	JU7	n/a	0-20mA	0-10Vdc
8	JU8	n/a	0-20mA	0-10Vdc

** Listed values are maximum ranges. Other ranges within these limits may be selected in software.*

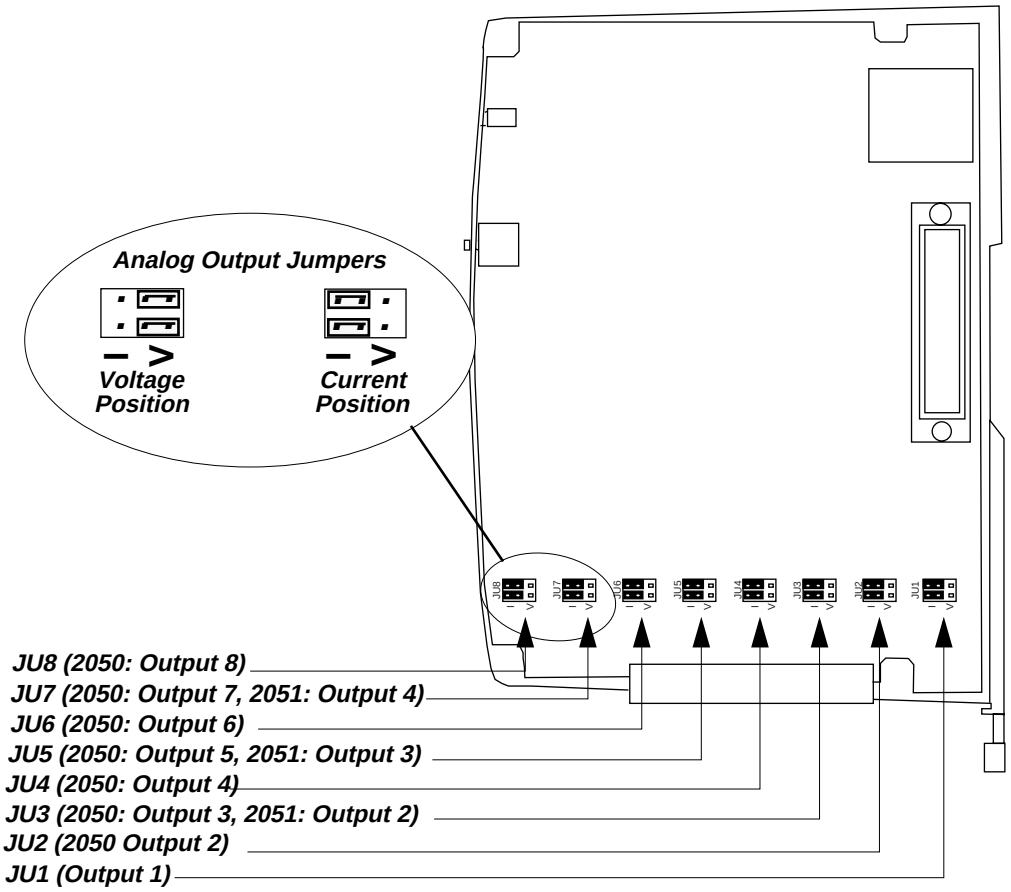

Analog Output Jumpers
Voltage Position
Current Position
JU8 (2050: Output 8)
JU7 (2050: Output 7, 2051: Output 4)
JU6 (2050: Output 6)
JU5 (2050: Output 5, 2051: Output 3)
JU4 (2050: Output 4)
JU3 (2050: Output 3, 2051: Output 2)
JU2 (2050 Output 2)
JU1 (Output 1)

Figure 2.7 PPC-205x Jumpers

Module Assembly

Modules should be assembled prior to mounting. The processor module is always the first module (left side) on a PPC system. To connect other modules, use the following procedure.

CAUTION! ***To avoid damaging your PPC system, never connect or disconnect modules that are powered.***

CAUTION! ***PPC modules contain sensitive electronic components. Be sure to observe ESD safety precautions such as wearing a ground strap.***

1. Make sure the red top and bottom module latches on the module to be added are in the unlocked position (pushed toward the back of the module. Refer to *Figure 2.8*.

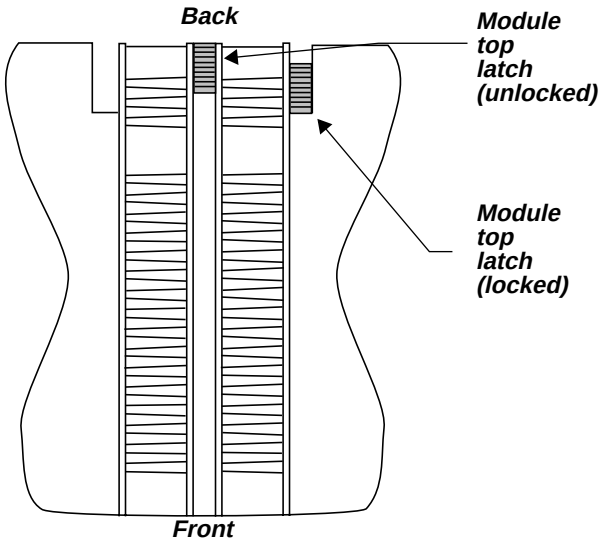


Figure 2.8 Assembled Modules Top View

2. Align the 4 interconnect tabs and their related slots, as well as the module expansion bus connector.

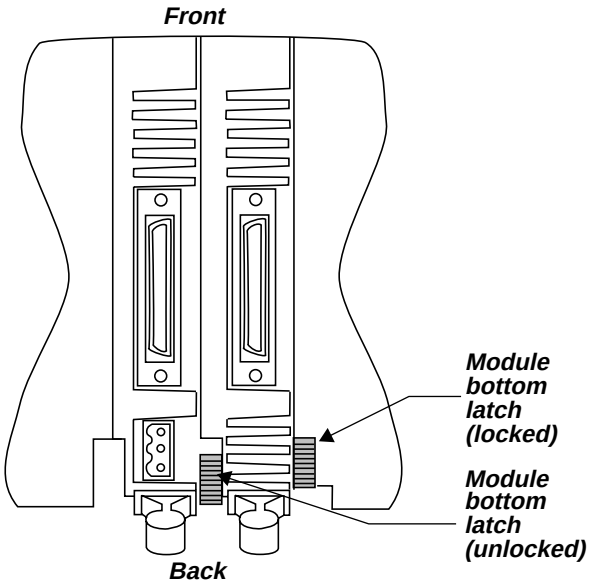


Figure 2.9 Assembled Modules Bottom View

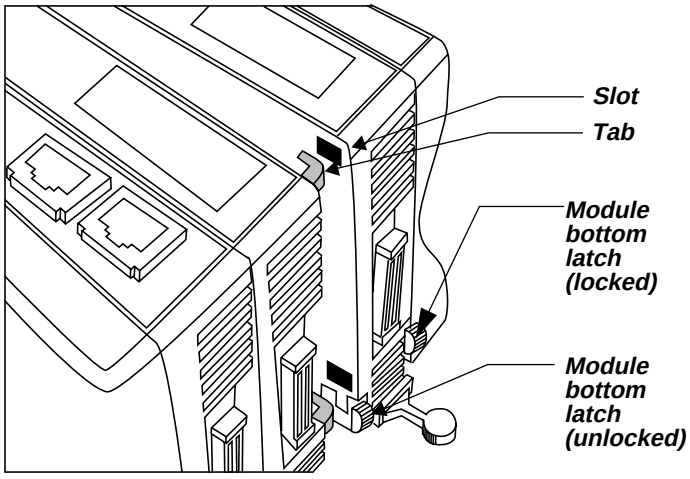


Figure 2.10 Modules Bottom/Side View

3. Gently press the modules together while observing the alignment of the tabs and slots, as well as the pins on the expansion bus connector.

4. When the module is properly seated, close the module latches on the processor by pushing the latch toward the front of the module. The modules are properly locked when there is a firm connection with no rocking or shifting.

5. Repeat these steps for any additional modules. When there are no additional modules, install the right end cap in a similar manner.

Module Disassembly

To separate modules, reverse the procedure in *Module Assembly on page 24*. When separating modules, gently rock and pull the modules apart.

CAUTION! ***To avoid damaging your PPC system, never connect or disconnect modules that are powered.***

Mounting Modules

Once the modules have been assembled, the PPC system may be mounted on a DIN rail or fastened directly to a vertical surface inside an electrical cabinet or other enclosure that requires a key or tool to open, or that has a safety interlock system. Consult *Table 7.2 on page 230* and *Figure 7.1 on page 230* to determine mounting hole spacing and installed clearances. See *Figure 1.1 on page 4* for a sample configuration of PPC system hardware.

WARNING! ***Install the PPC-2000 in a controlled environment, relatively free of contaminants, to reduce the risk of fire or electric shock.***

CAUTION! ***The controller may function incorrectly if the ambient temperature exceeds the operating specification. Make sure the air temperature surrounding the controller does not exceed 140°F (60°C).***

NOTE! ***During wiring and cabinet assembly, prevent debris from falling inside the PPC by removing the unit from the area, or cover the ventilation holes on the PPC system.***

DIN Rail Mounting

1. Each module in the assembly has a DIN rail latch. Pull all the latches to the open position. See *Figure 2.11*.

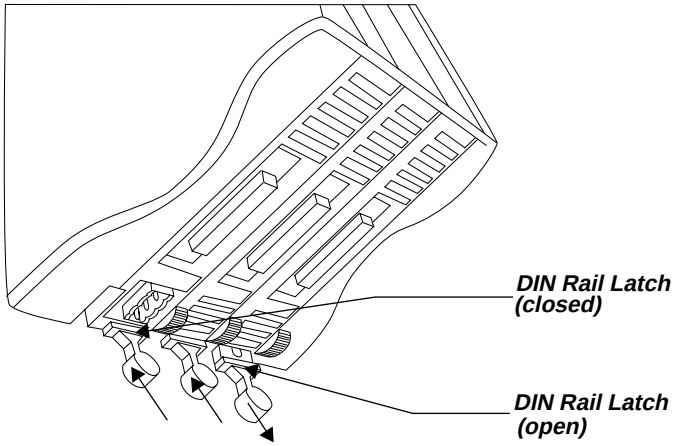


Figure 2.11 DIN Rail Latches

2. Place the module assembly on the upper lip of the DIN rail; push the lower side of the assembly over the lower lip of the DIN rail. See *Figure 2.12*.

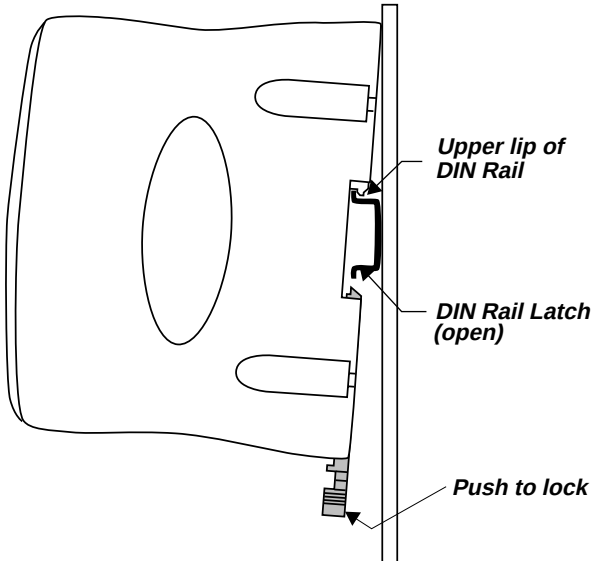


Figure 2.12 Mounting Assembled PPC Modules on a DIN rail (side)

3. Push the DIN rail latches up and under the lower lip of the DIN rail.

Panel Mounting

The PPC modules may be panel mounted using the mounting holes located on the end plates. The width of a system varies depending on the number of modules. Consult *Figure 7.1 on page 230* to determine installed clearances.

To panel mount the modules:

1. Locate a space with sufficient room for the appropriate number of modules and connecting wires. Refer to *Figure 7.1 on page 230* for a system footprint and dimensions.
2. The mounting holes are located on the end caps of the module assembly. Mark each mounting hole.
3. Drill and tap the four #10 mounting holes.
4. Place the modules such that the holes are aligned, insert the screws and tighten them.

Mounting Terminal Boards

Terminal boards support interfacing field I/O devices with the PPC modules. All terminal boards may be DIN rail or panel mounted. The following sections provide procedures for mounting the terminal boards.

There are smaller holes on each terminal board that may be used to secure wiring with tie wraps.

Refer to *Figure 2.13 on page 29* for AITB dimensions.

Refer to *Figure 2.14 on page 30* for EITB dimensions.

Refer to *Figure 2.15 on page 31* for TB50 dimensions.

For more detailed specification information, refer to *Chapter 7, Specifications*.

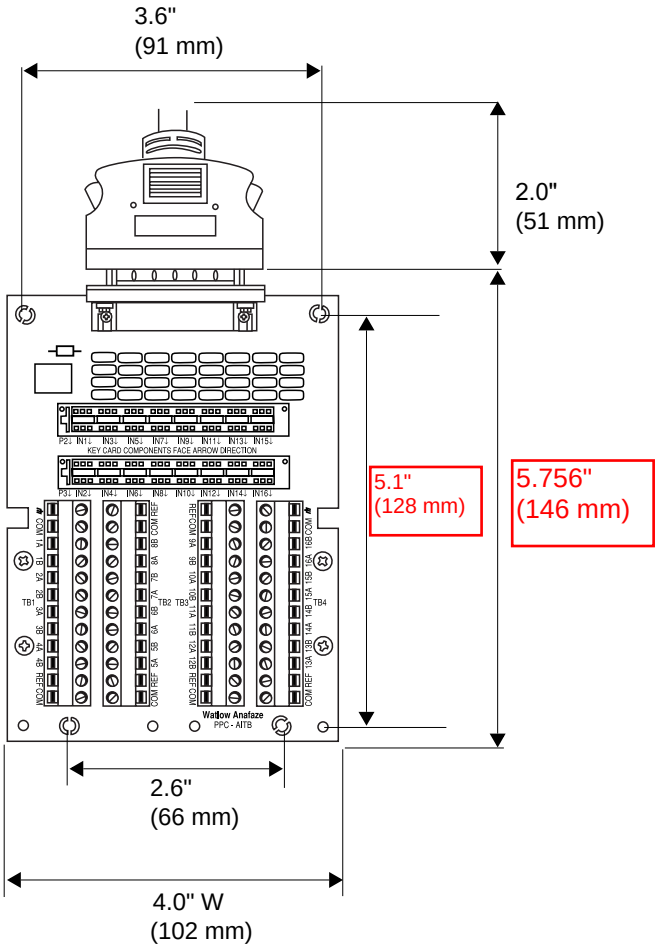


Figure 2.13 AITB Dimensions / Clearances

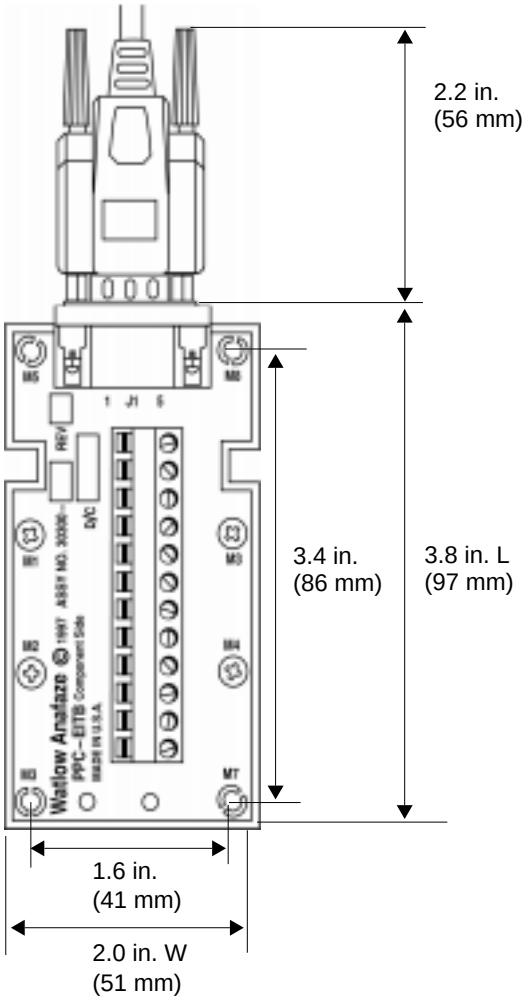


Figure 2.14 EITB Dimensions / Clearances

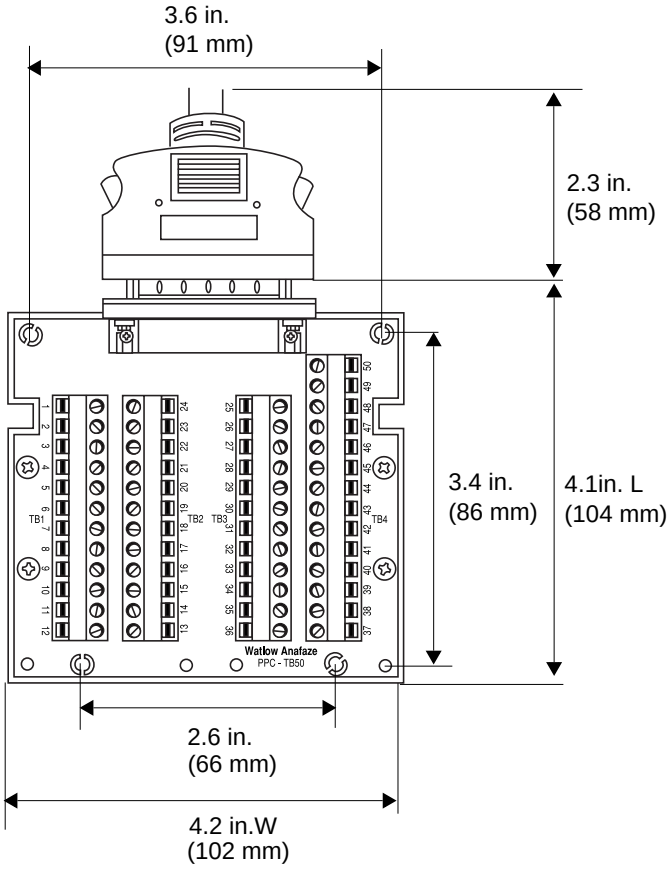


Figure 2.15 TB50 Dimensions / Clearances

DIN Rail Mounting

All factory terminal boards snap onto a DIN rail. A TB50 is shown in the following figures for illustration purposes only.

To install a terminal board on a DIN rail, place the hook side of the mounting mechanism over one of the DIN rail lips and snap the board over the other lip.

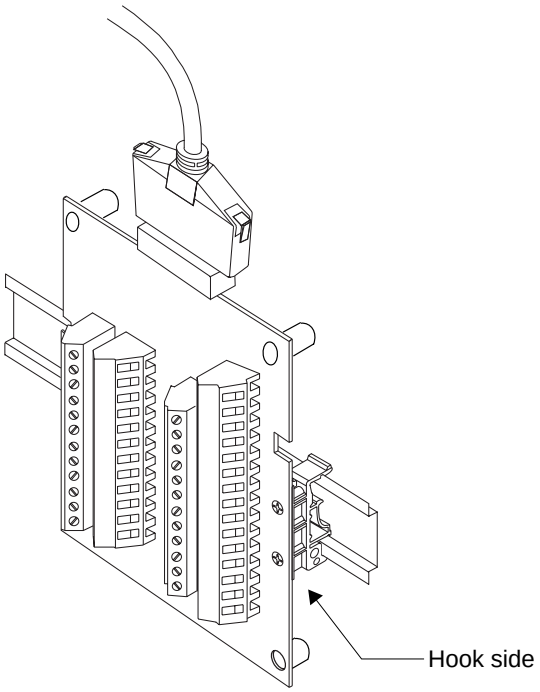


Figure 2.16 TB50 Mounted on DIN Rail (Front)

DIN Rail Removal

Place a flat blade screw driver through the slot in the board and hook the blade into the snap latch. Pry the snap latch away from the DIN rail lip and repeat for the other side. See *Figure 2.17*.

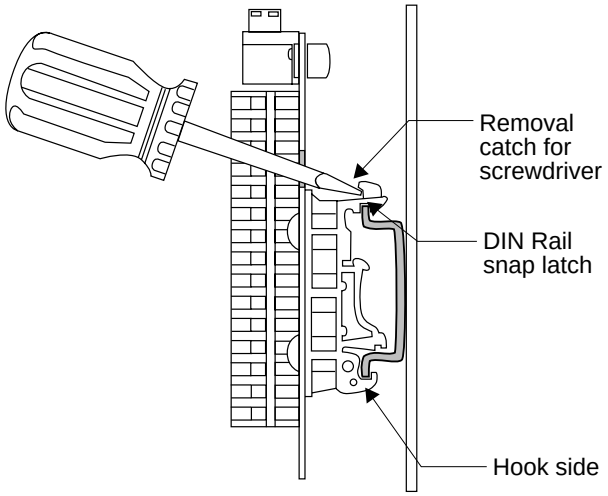


Figure 2.17 TB50 Mounted on DIN Rail (Side)

Panel Mounting

NOTE! ***When panel mounting terminal boards, remove the DIN rail brackets before mounting the boards.***

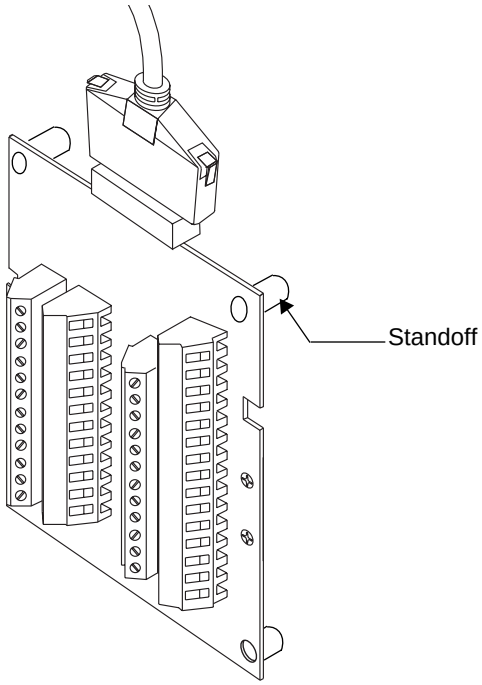


Figure 2.18 TB50 Panel Mounted

Stand-offs are provided for all terminal boards.

1. Remove the DIN rail mounting brackets from terminal board.
2. Select a location with enough clearance for the board and its SCSI cable. Refer to *Figure 2.15 on page 31* for installed clearances.
3. When a location has been determined for board, mark the four mounting holes.
4. Drill and tap the four #6-32 mounting holes.
5. Place the terminal board so the standoffs are aligned with the holes. insert the screws in to the standoffs and tighten them.

Mounting an SDAC Module

Follow these steps to install the SDAC module:

1. Select a location for installation. The SDAC is designed for wall mounting. It should be installed as close to the controller as possible.
2. Mark and drill four holes for screw mounting. Use the diagrams below for the correct locations.
3. Install the unit with the four #4 screws.

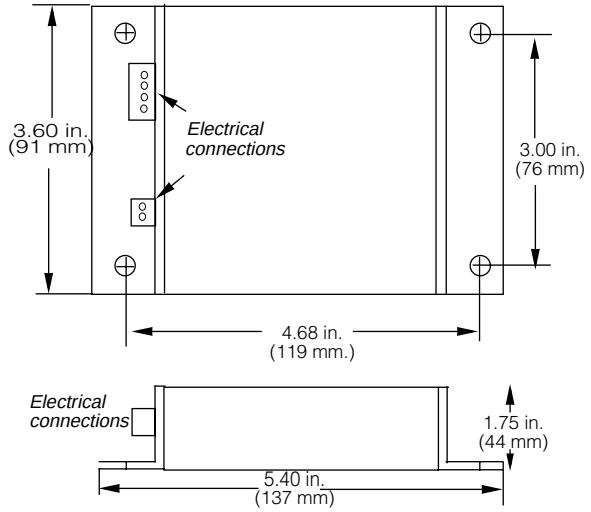


Figure 2.19 SDAC Dimensions

System Wiring

Successful installation and operation of the control system can depend on placement of the components and on selection of the proper cables, sensors, and peripheral components.

Routing and shielding of sensor wires and proper grounding of components can insure a robust control system. This section includes wiring recommendations, instructions for proper grounding and noise suppression, and considerations for avoiding ground loops.

CAUTION! ***Never route low power circuits next to high power AC wiring. Instead, physically separate high power circuits from the controller. If possible, install high voltage AC power circuits in a separate panel.***

CAUTION! ***Power, input or output circuits with hazardous voltage levels should not have any live accessible parts.***

Wiring Recommendations

Keep the following guidelines in mind when selecting wires and cables:

- Use stranded wire. (Solid wire can be used for fixed service; but it makes intermittent connections when you move it for maintenance.)
- Use #20 AWG TC extension wire. Larger or smaller sizes may be difficult to install, may break easily, or may cause intermittent connections.
- Use shielded wire. (The electrical shield protects the signals and the PPC-2000 from electrical noise.) Connect only one end of the shield to earth ground.
- Use copper wire for all connections other than thermocouple sensor inputs.

See *Table 2.9* for cable recommendations.

Table 2.9 Cable Recommendations

Function	Mfr. P/N	No. of Wires	AWG Gauge	Max. Length
Analog Inputs	Belden #9154 Belden #8451	2 2	20 22	
RTD Inputs	Belden #8772 Belden #9770	3 3	20 22	
TC Inputs	TC Ext. Wire	2	20	
Digital PID Outputs and Digital I/O	Belden #9539 Belden #9542	9 20	24 24	
Analog Outputs	Belden #9154 Belden #8451	2 2	20 22	
Computer Communication: RS232, RS422, RS485, or 20mA	Belden #9729 Belden #9730 Belden #9842 Belden #9843 Belden #9184	4 6 4 6 4	24 24 24 24 22	4000 ft. 4000 ft. 6000 ft.

Noise Suppression

The PPC-2000's outputs are designed to drive resistive loads. Open collector outputs can drive solid state relays. These relays may in turn operate more inductive types of loads such as

electromechanical relays, alarm horns and motor starters. Such devices may generate electromagnetic interference (EMI or noise). If the controller is placed close to sources of EMI, it may not function correctly. Below are some tips on how to recognize and avoid problems with EMI.

Symptoms of RFI/EMI

If your controller displays the following symptoms, suspect EMI:

- Measured values for analog inputs fluctuate or are incorrect.
- Open collector outputs fail.
- The watchdog time out LED on the Processor Module lights.

EMI may also damage the digital output circuit—so digital outputs will not turn on. If the digital output circuit is damaged, return the controller to Watlow Anafaze for repair.

Avoiding Noise Problems

To avoid RFI/EMI noise problems:

- PPC-2022 32 analog input module must be used with isolated (ungrounded) thermocouples only.
- PPC-2022 32 analog input module should not be used with thermocouples that are embedded within heaters as some cartridge heaters are constructed.
- Separate the 120 or 240Vac power leads from the low level input and output leads connected to the controller. Don't run the digital I/O or control output leads in bundles with 120Vac wires.
- Where possible, use solid state relays (SSRs) instead of electromechanical (EM) relays. If you must use EM relays, try to avoid mounting them in the same panel as the PPC-2000 series equipment.
- When switching an inductive load such as an electromechanical relay or solenoid, install a snubber across the load. Use a 0.01 microfarad capacitor rated at 1000Vac (or higher) in series with a 47 Ohm, 0.5 watt resistor across the NO contacts of the relay load. See *Chapter 2, Connecting to the Relay Outputs on the PPC-206x on page 70* for specific instructions on using snubbers with the PPC-206x modules.

- You can use other voltage suppression devices, but they are not usually required. For instance, you can place a metal oxide varistor (MOV) rated at 130Vac for 120Vac control circuits across the load, which limits the peak AC voltage to about 180Vac. You can also place a transorb (back to back zener diodes) across the digital output, which limits the digital output voltage.

The above steps will eliminate most EMI/RFI noise problems. If you have further problems or questions, please contact Watlow Anafaze.

Avoiding Ground Loops

Ground Loops can cause instrument errors or malfunctions. Do not connect any of the following pins to each other or to earth ground:

- DC power common terminals on the PPC power supply and PPC-2010 Processor Module
- DC common terminals on TB50s
- Analog common terminals on AITBs
- Signal common terminals on the EITB or other devices connected to the encoder inputs on a PPC-2030

Watlow Anafaze strongly recommends that you:

- Isolate outputs through solid state relays, where possible.
- Isolate RTDs or "bridge" type inputs from ground.

Connecting I/O to the PPC-2010

A TB50 connects to the PPC-2010 Processor module through the 50 pin SCSI connector. Refer to *Figure 2.20 on page 38*. The terminal block interfaces to field wiring of the digital I/O (sensors, actuators, relays, SSRs, etc.).

Connecting the TB50 to the PPC-2010 Module

Refer to *Figure 2.20 on page 38*. Connect the SCSI connector from the PPC-2010 module to the TB50.

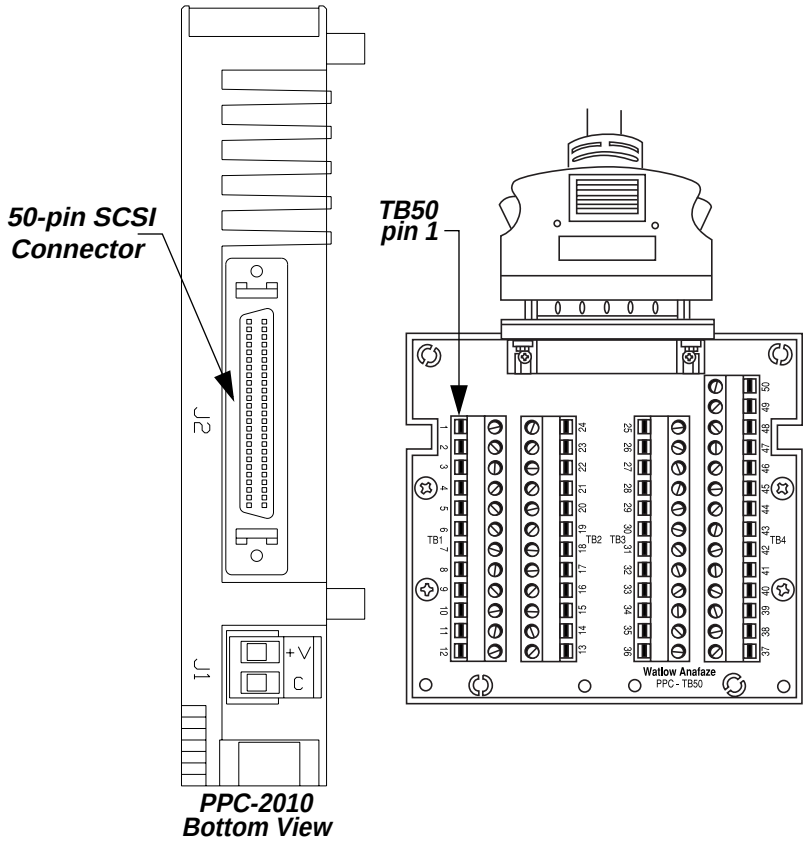


Figure 2.20 PPC-2010 Connection to TB50

NOTE! ***If more than one module in the PPC system is connected to a terminal board using a 50-pin SCSI connector, label each end of each cable and each terminal board with the address of the module to which it should be connected.***

TB50 Connections

Connect digital inputs and digital outputs for control signals, alarms, and digital field I/O to the TB50. When connected to the PPC-2010 Processor module, one pulse signal input and up to five SDAC analog output modules can be connected to the TB50. *Table 2.10 on page 39* shows the TB50 pinout for use with the PPC-2010.

Use 14 to 22 AWG wire. When making connections, tighten to 0.5 to 0.6 Nm, or 4.5 to 5.4 inch-pound.

Table 2.10 Processor Module I/O Connections

Module I/O Number	TB-50 Terminal	AnaWin3 Name (Dig I/O Spreadsheet)[1]
Digital In/Out 1 Counter 1 Frequency 1	1	PPC1:Proc 0.0.1 PPC1:Proc 0.1.1C[2] PPC1:Proc0.2.1F
Digital In/Out 2	2	PPC1: Proc 0.0.2
Digital In/Out 3	3	PPC1: Proc 0.0.3
Digital In/Out 4	4	PPC1: Proc 0.0.4
Digital In/Out 5	5	PPC1: Proc 0.0.5
Digital In/Out 6	6	PPC1: Proc 0.0.6
Digital In/Out 7	7	PPC1: Proc 0.0.7
Digital In/Out 8	8	PPC1: Proc 0.0.8
Digital In/Out 9	9	PPC1: Proc 0.0.9
Digital In/Out 10	10	PPC1: Proc 0.0.10
Digital In/Out 11	11	PPC1: Proc 0.0.11
Digital In/Out 12	12	PPC1: Proc 0.0.12
Digital In/Out 13	13	PPC1: Proc 0.0.13
Digital In/Out 14	14	PPC1: Proc 0.0.14
Digital In/Out 15	15	PPC1: Proc 0.0.15
Digital In/Out 16	16	PPC1: Proc 0.0.16
Digital In/Out 17	17	PPC1: Proc 0.0.17
Digital In/Out 18	18	PPC1: Proc 0.0.18
Digital In/Out 19	19	PPC1: Proc 0.0.19
Digital In/Out 20	20	PPC1: Proc 0.0.20
Digital In/Out 21	21	PPC1: Proc 0.0.21
Digital In/Out 22	22	PPC1: Proc 0.0.22
Digital In/Out 23	23	PPC1: Proc 0.0.23
Digital In/Out 24	24	PPC1: Proc 0.0.24
Digital Out 25	25	PPC1: Proc 0.0.25
Digital Out 26	26	PPC1: Proc 0.0.26
Digital Out 27	27	PPC1: Proc 0.0.27
Digital Out 28	28	PPC1: Proc 0.0.28
Digital Out 29	29	PPC1: Proc 0.0.29
Digital Out 30	30	PPC1: Proc 0.0.30
Digital Out 31	31	PPC1: Proc 0.0.31
Digital Out 32	32	PPC1: Proc 0.0.32
Digital Out 33	33	PPC1: Proc 0.0.33
Digital Out 34	34	PPC1: Proc 0.0.34

Module I/O Number	TB-50 Terminal	AnaWin3 Name (Dig I/O Spreadsheet)[1]
Digital Out 35	35	PPC1: Proc 0.0.35
Digital Out 36	36	PPC1: Proc 0.0.36
Digital Out 37	37	PPC1: Proc 0.0.37
Digital Out 38	38	PPC1: Proc 0.0.38
Digital Out 39	39	PPC1: Proc 0.0.39
Digital Out 40	40	PPC1: Proc 0.0.40
Digital Out 41 SDAC Out 41	41	PPC1: Proc 0.0.41
Digital Out 42 SDAC Out 42	42	PPC1: Proc 0.0.42
Digital Out 43 SDAC Out 43	43	PPC1: Proc 0.0.43
Digital Out 44 SDAC Out 44	44	PPC1: Proc 0.0.44
Digital Out 45 SDAC Out 45	45	PPC1: Proc 0.0.45
Digital Out 46 SDAC Clock	46	PPC1: Proc 0.0.46
Global Alarm	47	PPC1: Proc 0.0.47
CPU Watchdog	48	PPC1: Proc 0.0.48
Com (DC Common for Input Return)	49,50	N/A

1. The name is shown for the first PPC-2000 in the system. See *Digital I/O on page 132* for a complete explanation of digital I/O names.

2. Both count and frequency are measured for the pulse input. See *Inputs on page 127* for an explanation of analog input names.

Connecting Digital Inputs

The PPC-2010 module can accept digital inputs. When the resistance of an input device is 27 kOhm or greater, the input is considered off by the PPC-2000. When the resistance is 1 kOhm or less, the input is considered on.

To install a switch as a digital input, connect one lead to the DC Common input return on the TB50. Connect the other lead to the desired digital input on the TB50. Refer to *Table 2.10 on page 39* for screw terminal numbering.

Use the Digital I/O parameters to configure digital inputs. Refer to *Digital I/O on page 132.*

{Add examples with transistor inputs on digital and pulse inputs.}

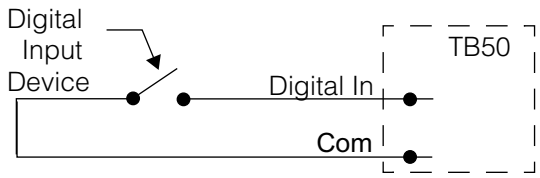


Figure 2.21 Wiring Digital Inputs

Connecting Counter or Frequency Inputs

PPC-2010 module accepts a single-phase pulse signal from devices such as encoders. Counts and frequencies of the inputs may be scaled with user selectable parameters. See *Setting up User Selectable Linear Inputs on page 98* for more information.

The PPC-2010 module can accommodate encoder signals up to 24Vdc. The following figures illustrate connecting encoders:

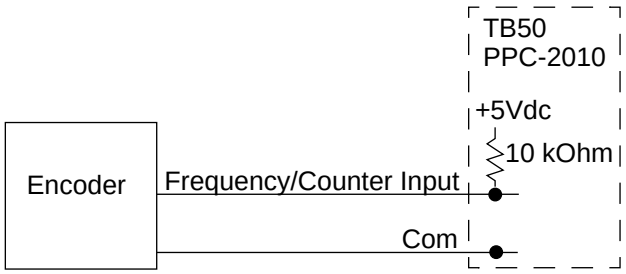


Figure 2.22 Encoder with 5Vdc TTL Signal

Connecting Digital Outputs

The digital outputs sink current from a load connected to the controller's power supply, or another power supply referenced to the PPC-2000 power common. Do not exceed +24 volts on the outputs.

If you must tie the external load to ground, or if you cannot connect it as shown in *Figure 2.23 through Figure 2.25*, use a solid state relay to drive your load.

The outputs conduct current when they are LOW or ON. The maximum current sink capability is 100mA at 24Vdc. They cannot 'source' current to a load.

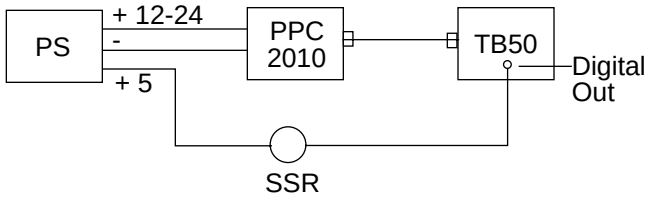


Figure 2.23 Powering Output with 5Vdc from PPC Supply

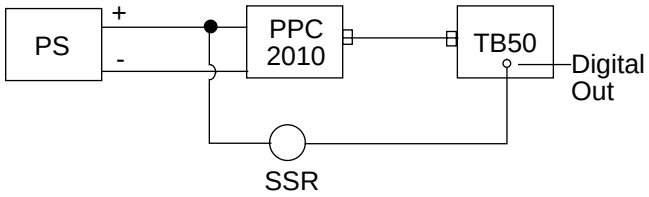


Figure 2.24 Powering Output with 12-24Vdc from PPC supply

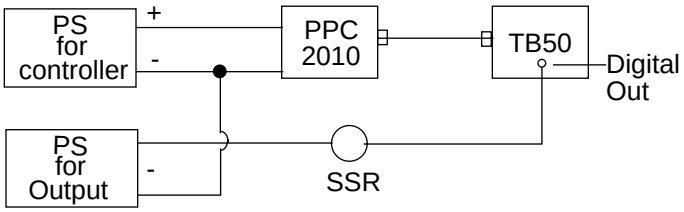


Figure 2.25 Powering Output with Separate Power Supplies

Using the CPU Watchdog Signal

The PPC system constantly monitors the functioning of its microprocessor. The CPU watchdog output is Low (on) when the microprocessor is operating; when it stops operating, the output goes High (off). This sink output is available on screw terminal #48 on the TB50 attached to the PPC-2010 Processor module.

The figure below shows the recommended circuit for the CPU Watchdog signal output.

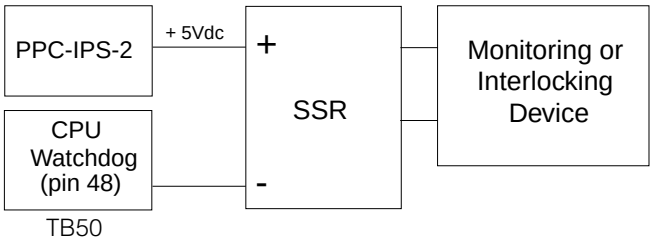


Figure 2.26 Recommended circuitry for CPU Watchdog

SDAC Connections

Up to 5 Serial Digital to Analog Converter (SDAC) modules can be connected to digital outputs on the processor module. Each can provide an analog current or voltage signal.

Single SDAC Systems

Use the **+5V** output on the PPC-IPS-2 to power SDACs. Use stranded 18 to 22 gauge wire for most installations. Refer to *Figure 2.27 on page 44* for system setup.

- Connect SDAC Pin 1 to the **+5V** terminal on the power supply.
- Connect SDAC Pin 2 to the **DC COM** terminal on the power supply.
- If a separate power supply is used, connect the common to the **DC COM** on the PPC-2000 power supply.
- Connect SDAC Pin 3 to the SDAC clock output on the processor's TB50 (digital output **46**).
- Connect SDAC pin 4 to the desired control output on the TB50 (digital output **41-45**).
- Connect SDAC pins 5 and 6 to the input of the controlled device.

Multiple SDAC Systems

As many as 5 SDACs can be run from one PPC-2000. Be sure to provide sufficient current. Use stranded 18 to 22 gauge wire for most installations. Refer to *Figure 2.27* for system setup.

- Connect SDAC Pin 1 to the **+5V** terminal on the power supply.
- Connect SDAC Pin 2 to the **DC COM** terminal on the power supply.
- If a separate power supply is used, connect the common to the **DC COM** on the PPC-2000 power supply.
- Connect SDAC Pin 3 to the SDAC clock output on the TB50 (digital output **46**).
- Connect SDAC pin 4 to the desired control output on the TB50 (digital output **41-45**).
- Connect SDAC pins 5 and 6 to the input of the controlled device.

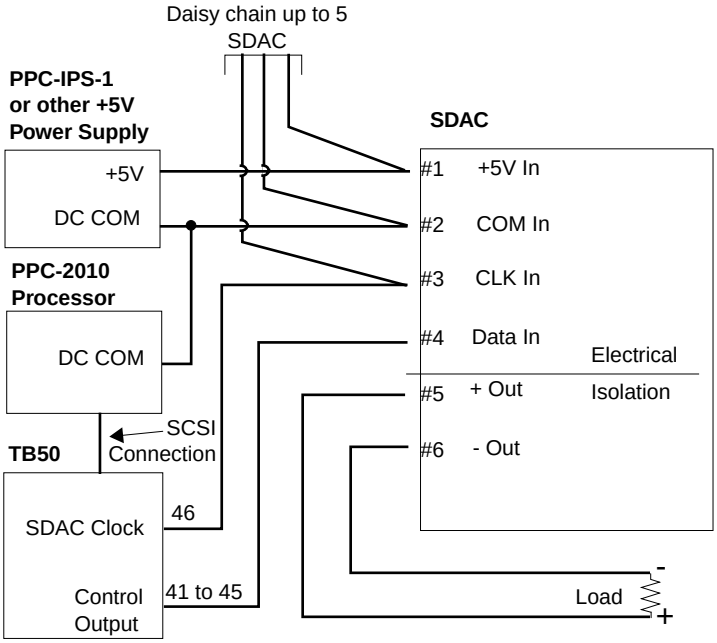


Figure 2.27 Wiring Single/Multiple SDACs

Connecting Analog Inputs to the PPC-2021 — 2025

The Analog Input Terminal Board (AITB) connects to the analog input module through the SCSI connector (bottom center of the analog input module). The AITB accommodates wiring thermocouples, RTDs, and voltage/current linear inputs.

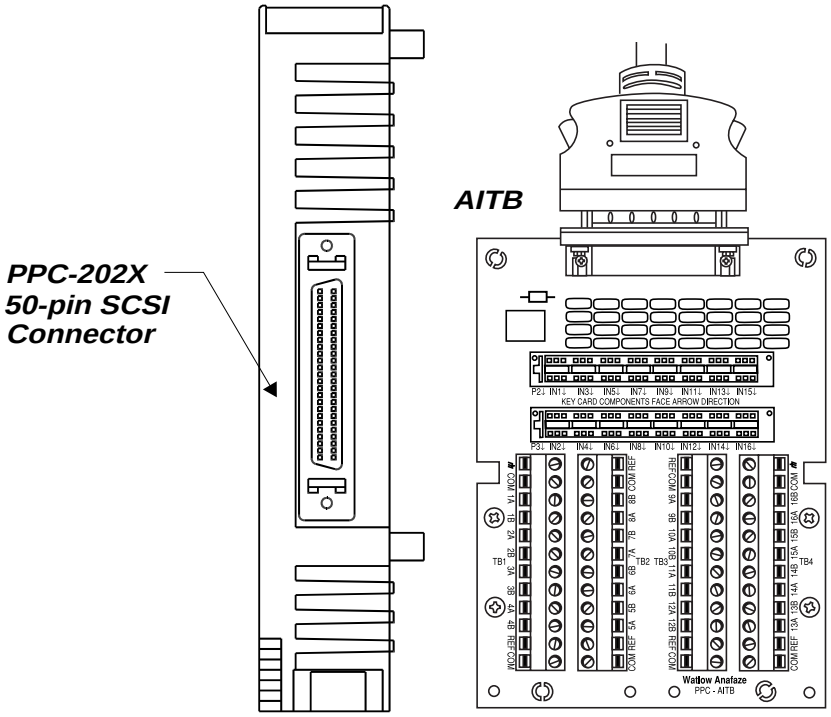


Figure 2.28 PPC-2021 — 2025 Connection to AITB

Connecting the AITB to the PPC-202x

Refer to *Figure 2.28*. Connect the 50-pin SCSI connector from the analog input module(s) to the analog input terminal block (AITB). *Table 2.13 on page 48* shows the AITB pinout.

NOTE! ***If more than one AITB has been installed, it may be useful to label both ends of the SCSI cable and the AITB with the address selected on the corresponding analog input or high isolation analog input module.***

Sensor Keys

Sensor keys with built-in jumpers or resistors are used to customize the AITB for various sensor types. Insert the appropriate key in the socket provided on the AITB. See *Table 2.11* for a description of the various keys. There are two rows of eight key sockets. Each socket location is labeled IN1 to IN16 which correlate with each Analog In or High Isolation Analog input address. Keys should be inserted with the component side facing the terminal blocks. *Figure 2.29* illustrates key installation.

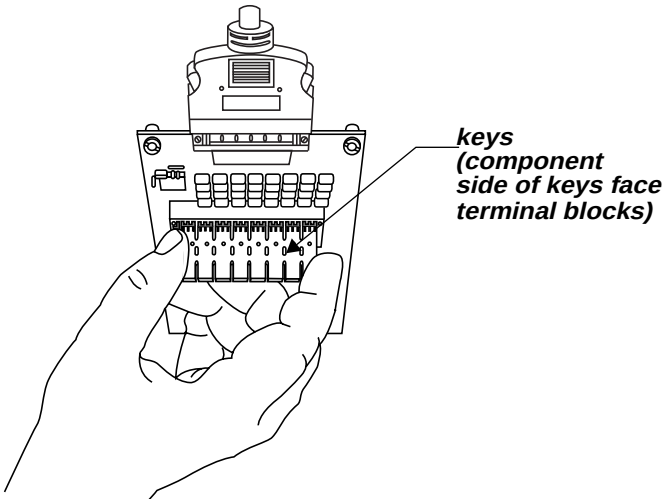


Figure 2.29 Inserting Sensor Keys in AITB

Table 2.11 Sensor Keys

Key	Color	Sensors	Used with
TC	None	TC and Voltage	All
RTD	Red	2-Wire or 3-Wire Platinum 100Ω RTD	2021 2024 2025
Differential Current	Blue	0-20mA	2021 2024 2025
Single-Ended Current	Black	0-20mA	2022

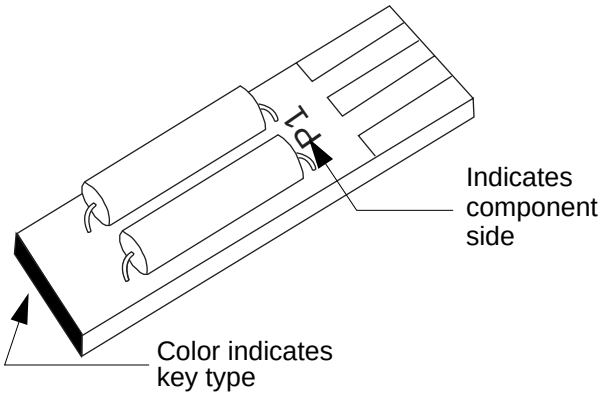


Figure 2.30 An Input Key

AITB Connections

The AITB accommodates wiring thermocouples, RTDs, and voltage/current linear inputs for all analog input modules. *Table 2.12* describes each analog module and *Table 2.13 on page 48* correlates the AITB labels with the sensor wire connections for the various modules.

When connecting sensor wires, tighten to 0.5 – 0.6 Nm, or 4.5 – 5.4 inch-pound.

Table 2.12 Numbers and Types of Inputs by Module Type

Module	Number of Inputs	Differential or Single-ended	Note
PPC-2021	16	Differential	
PPC-2022	32	Single-ended	
PPC-2024	8	Differential	High Isolation
PPC-2025	16	Differential	High Isolation

Table 2.13 Sensor Connections to the AITB

Module I/O Number	AITB Connection (Terminal Numbers)				AnaWin3 Name (Input Spreadsheet)[1]
	Differential PPC-2021 PPC-2024 PPC-2025		Single-Ended PPC-2022[2]		
	+	-	+	-	
Input 1	1A	1B	1A	Com	PPC1:AI 1.1
Input 2	2A	2B	1B	Com	PPC1:AI 1.2
Input 3	3A	3B	2A	Com	PPC1:AI 1.3
Input 4	4A	4B	2B	Com	PPC1:AI 1.4
Input 5	5A	5B	3A	Com	PPC1:AI 1.5
Input 6	6A	6B	3B	Com	PPC1:AI 1.6
Input 7	7A	7B	4A	Com	PPC1:AI 1.7
Input 8	8A	8B	4B	Com	PPC1:AI 1.8
Input 9	9A	9B	5A	Com	PPC1:AI 1.9
Input 10	10A	10B	5B	Com	PPC1:AI 1.10
Input 11	11A	11B	6A	Com	PPC1:AI 1.11
Input12	12A	12B	6B	Com	PPC1:AI 1.12
Input 13	13A	13B	7A	Com	PPC1:AI 1.13
Input 14	14A	14B	7B	Com	PPC1:AI 1.14
Input 15	15A	15B	8A	Com	PPC1:AI 1.15
Input16	16A	16B	8B	Com	PPC1:AI 1.16
Input 17	n/a	n/a	9A	Com	PPC1:AI 1.17
Input 18	n/a	n/a	9B	Com	PPC1:AI 1.18
Input 19	n/a	n/a	10A	Com	PPC1:AI 1.19
Input 20	n/a	n/a	10B	Com	PPC1:AI 1.20
Input 21	n/a	n/a	11A	Com	PPC1:AI 1.21
Input 22	n/a	n/a	11B	Com	PPC1:AI 1.22
Input 23	n/a	n/a	12A	Com	PPC1:AI 1.23
Input 24	n/a	n/a	12B	Com	PPC1:AI 1.24
Input 25	n/a	n/a	13A	Com	PPC1:AI 1.25
Input 26	n/a	n/a	13B	Com	PPC1:AI 1.26
Input 27	n/a	n/a	14A	Com	PPC1:AI 1.27
Input 28	n/a	n/a	14B	Com	PPC1:AI 1.28
Input 29	n/a	n/a	15A	Com	PPC1:AI 1.29
Input 30	n/a	n/a	15B	Com	PPC1:AI 1.30
Input 31	n/a	n/a	16A	Com	PPC1:AI 1.31
Input 32	n/a	n/a	16B	Com	PPC1:AI 1.32

[1] The AnaWin3 name is shown for the first Analog Input module on the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of analog input naming.

[2] For the single-ended module the negative sensor lead is connected to any one of the Com (Analog Common) terminals.

Table 2.14 Power Connections on AITB

Voltage	AITB Terminals
10.00V Ref	Ref (4 PL.)
Analog Common	Com (8 PL.)

NOTE! ***The Ref voltage is provided for special sensor types. Do not use this voltage without consulting Watlow Anafaze.***

Connecting Thermocouples

NOTE! ***Connect thermocouple shields directly to a good frame or chassis ground. Connect thermocouple shields at one end only, either near the terminal board or the sensor end.***

A thermocouple is connected in a differential configuration by wiring the positive signal lead to the **A** terminal of the proper input and the negative signal lead to the **B** terminal of the same input. The designators are located on the terminal block cards near each screw terminal. See *Figure 2.31.*

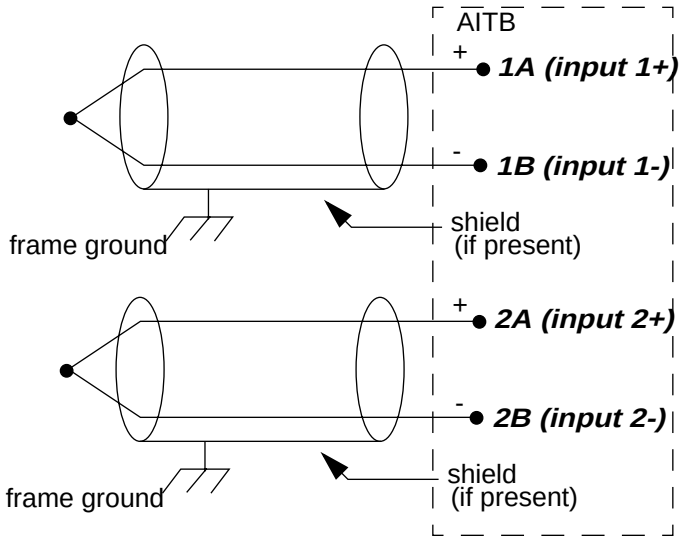


Figure 2.31 Thermocouples Connected to Differential Inputs 1 and 2

A T/C is connected to a single-ended input by wiring the positive signal lead to the **A** or **B** terminal and the negative signal lead to the analog **COM** terminal. See *Figure 2.32* and refer to *Table 2.13 on page 48*.

WARNING! ***Thermocouples connected to single-ended inputs (PPC-2022) must be isolated (ungrounded) and should not be embedded within heater elements as some cartridge heaters are constructed.***

.

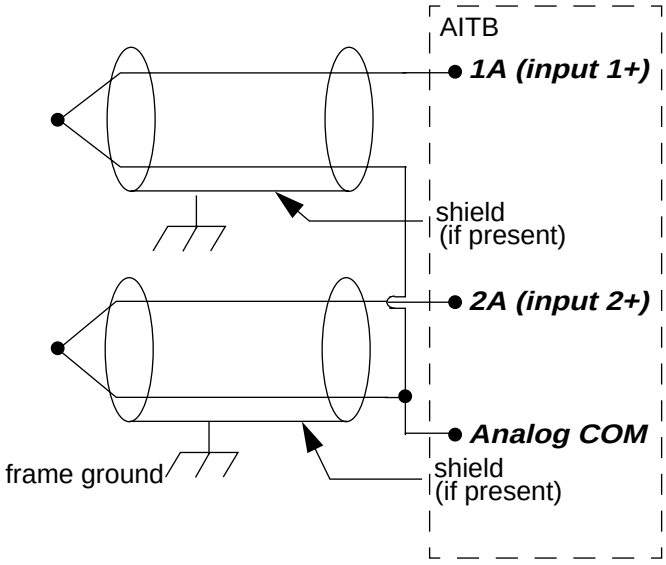


Figure 2.32 Thermocouples Connected to Single-ended Inputs 1 and 2

Connecting RTDs

Two-wire RTDs are connected between the **A** and **B** terminals of the selected input. They may only be used with a differential analog input module. A jumper wire must be added on the terminal board from the **B** terminal to the **COM** terminal. See *Figure 2.33 on page 51*.

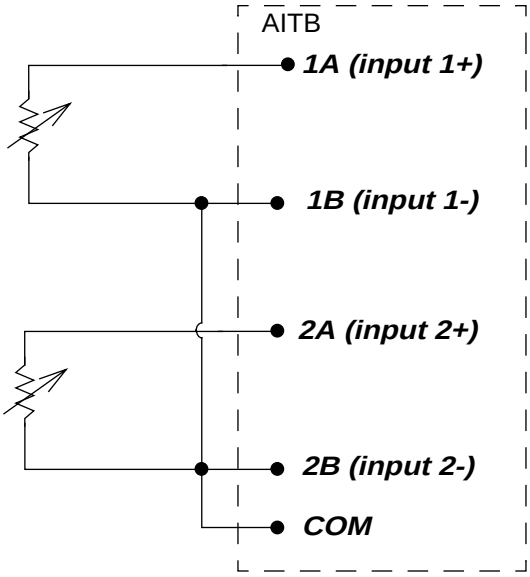


Figure 2.33 Wiring 2-Wire RTDs: Input 1 and 2 Shown

Three-wire RTDs may only be used with differential analog input modules. The single wire side of a 3-wire RTD sensor connects to the A terminal, one of the double wire sides connects to the B terminal and the other connects to the COM terminal. Both **A** and **B** terminals must be of the same desired input, i.e., **1A** and **1B**. See *Figure 2.34*.

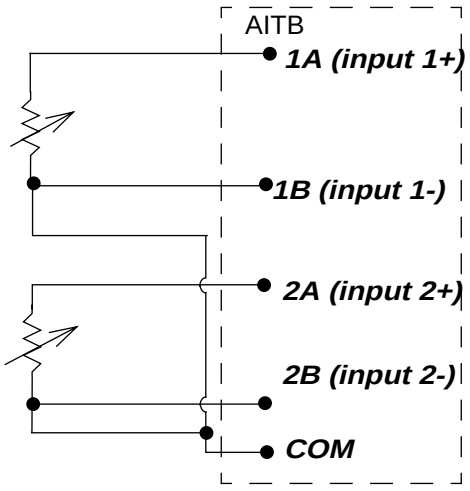


Figure 2.34 Wiring 3-Wire RTDs: Input 1 and 2 Shown

CAUTION! ***Do not connect the COM terminals on the AITB to earth ground. Connecting COM to earth ground limits the input protection to ±10Vac and could result in damage to the input circuit.***

Connecting Sensors with Linear Voltage Signals

For sensors with single output connections, connect the negative input (**B** terminal) to the sensor common terminal.

Differential voltage transducers or sensors, such as bridges, should be connected with the positive signal lead on the **A** terminal and the negative signal lead to the **B** terminal for the selected input. See *Figure 2.35*.

Check sensor power supply connections and ground connections to avoid exceeding the common mode range of the Analog Input module or creating ground loops.

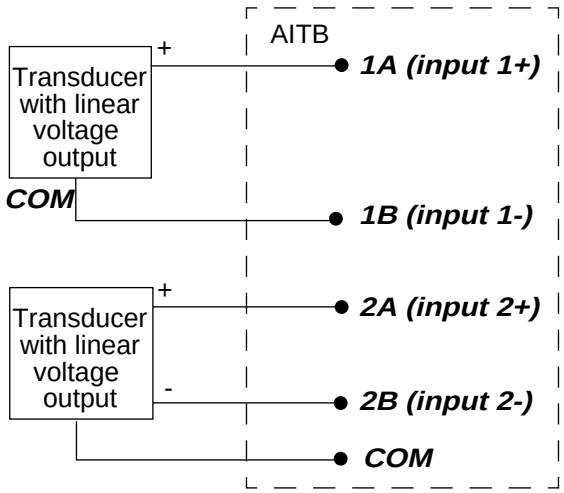


Figure 2.35 Connecting Linear Voltage Signals to Differential Inputs 1 and 2

Single-ended voltage sources should have the positive lead on the positive terminal of the desired input. The negative lead should be connected to the **COM** terminal. See *Figure 2.36 on page 53*.

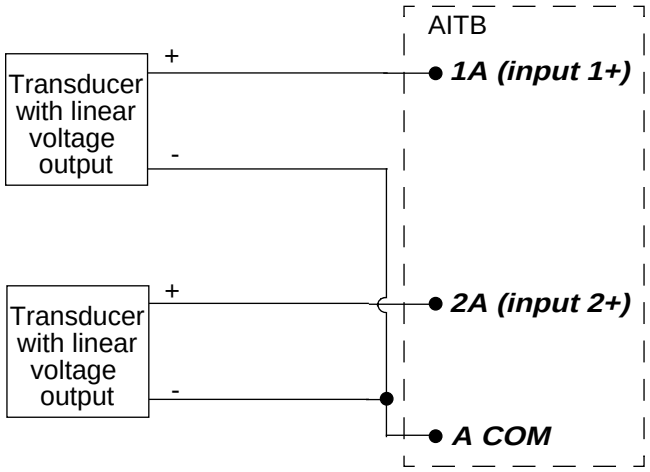


Figure 2.36 Connecting Linear Voltage Signals to Single-ended Inputs 1 and 2

Connecting Sensors with Linear Current Signals

Differential current transducers or sensors should be connected with the positive signal lead on the **A** terminal and the negative signal lead to the **B** terminal for the selected input. See *Figure 2.37*.

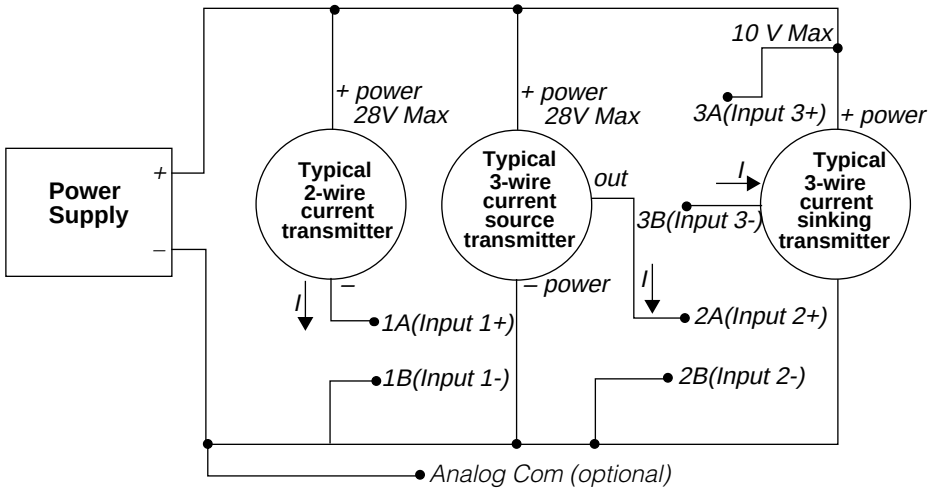


Figure 2.37 Connecting Current Inputs to a Differential Input Module: Input 1, 2, and 3 Shown

Single-ended current sources should be have the positive lead on the positive terminal of the desired input. The negative lead should be connected to the **COM** terminal. See *Figure 2.38 on page 54*.

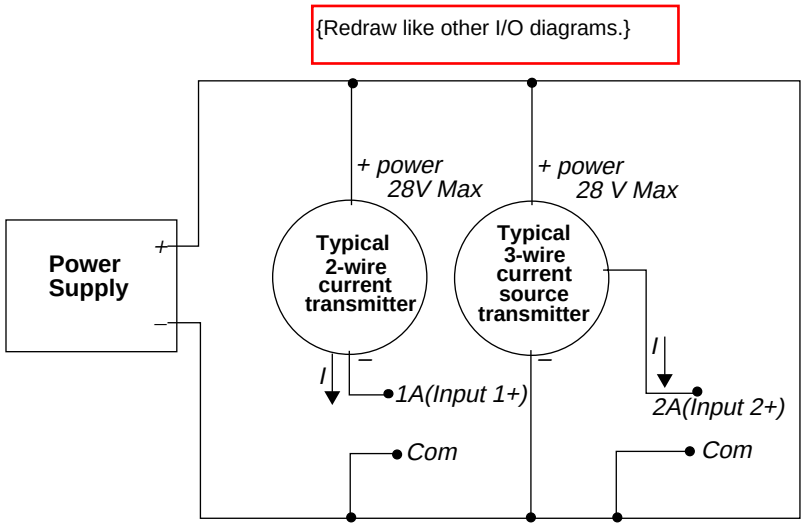


Figure 2.38 Connecting Current Inputs to a Single-ended Analog Input Module: Input 1 and 2 Shown

Connecting Encoders and Analog Outputs to the PPC-2030

The PPC-2030 accepts four encoder inputs and outputs four current or voltage signals. Encoder signals are connected to the module via two HD-15 cables. These cables may be used in conjunction with up to two EITBs or may be connected directly from the encoders to the module.

Connect analog outputs via the analog output terminal block as shown in *Figure 2.39*.

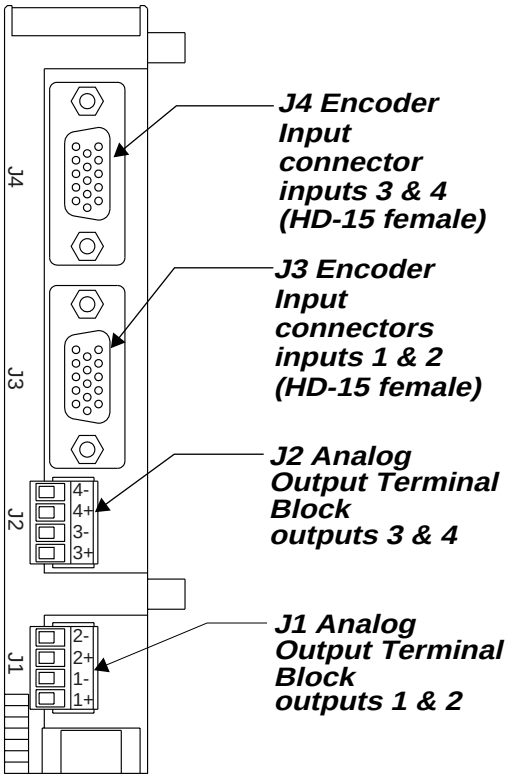


Figure 2.39 PPC-2030 Connections (Bottom View)

Connecting the Encoder Input Cable to the PPC-2030

Connect the 15-pin, HD cable(s) between J1 or J2 on the PPC-2030 shown in *Figure 2.39* and the encoder input terminal block (EITB).

Figure 2.40 on page 56 illustrates the EITB. *Table 2.15 on page 56* shows the EITB pinout and *Table 2.18 on page 59* shows the HD D-type connector pinout. *Analog Output Connections on page 60* discusses analog outputs from the PPC-2030.

NOTE! ***If more than one EITB has been installed, it may be useful to label both ends of the HD-15 connector and each EITB with the corresponding module address and jack number.***

EITB Connections

Table 2.15 and *Table 2.16* indicate the encoder connections to the EITB connected to the Encoder In Analog Out module. *Table 2.17 on page 57* lists the terminals that carry power.

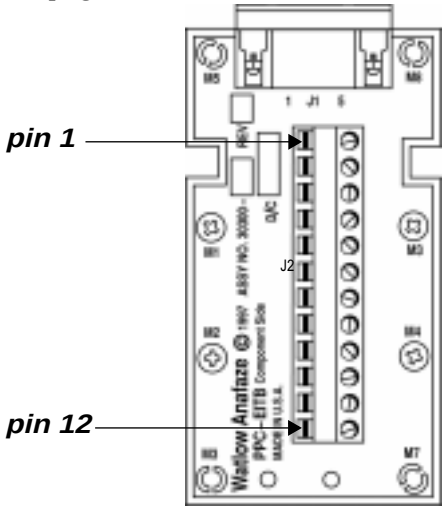


Figure 2.40 PPC-EITB-1

Table 2.15 Encoder Connections to the EITB Connected to J3 on the PPC-2030

Module I/O Number	EITB Terminal				AnaWin3 Name (Input Spreadsheet)[1]
	Phase 1		Phase 2		
	+	-	+	-	
Count 1 Frequency 1	2	3	4	5	PPC1:EIAO 11.1.1 C PPC1:EIAO 11.2.1 F
Count 2 Frequency 2	8	9	10	11	PPC1:EIAO 11.1.2 C PPC1:EIAO 11.2.2 F

Table 2.16 Encoder Connections to the EITB Connected to J4 on the PPC-2030

Module I/O Number	EITB Terminal				AnaWin3 Name (Input Spreadsheet)[1]
	Phase 1		Phase 2		
	+	-	+	-	
Count 3 Frequency 3	2	3	4	5	PPC1:EIAO 11.1.3 C PPC1:EIAO 11.2.3 F
Count 4 Frequency 4	8	9	10	11	PPC1:EIAO 11.1.4 C PPC1:EIAO 11.2.4 F

1. The AnaWin3 name is shown for the Encoder In Analog Out module with address 11 on the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of Analog input naming. Both count and frequency are measured for each input.

Table 2.17 Power Connections on EITB

Voltage	EITB Terminals
+5Vdc	1, 7
COM	6, 12

Encoder Wiring

The EITB accommodates four configurations of frequency/ counter inputs:

- Single-ended/single phase
- Single-ended/quadrature
- Differential/single phase
- Differential/quadrature

Note that these are four unique inputs and each input has two phases. Both phases are used only in quadrature mode nominally.

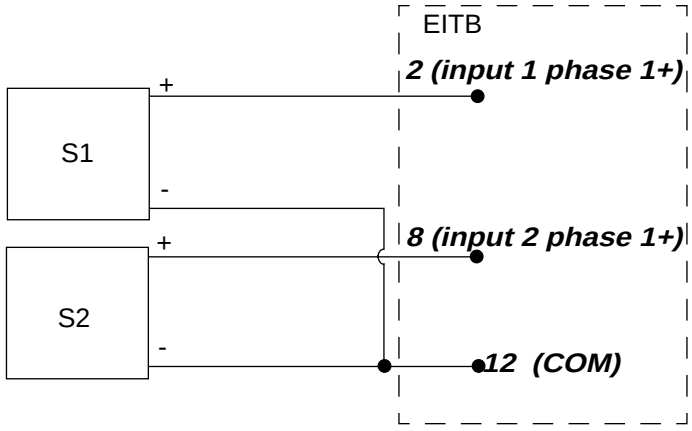


Figure 2.41 EITB Single-ended Single Phase Connections: Input 1 and 2 Shown

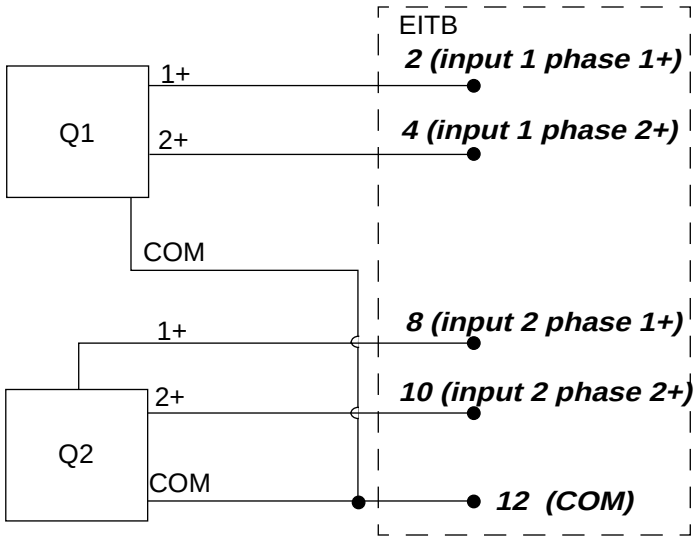


Figure 2.42 EITB Single-ended Quadrature Connections: Input 1 and 2 Shown

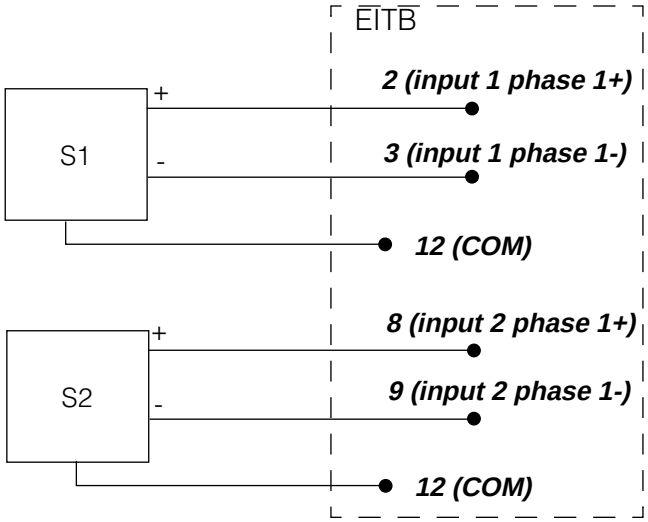


Figure 2.43 EITB Differential Single Phase Connections: Input 1 and 2 Shown

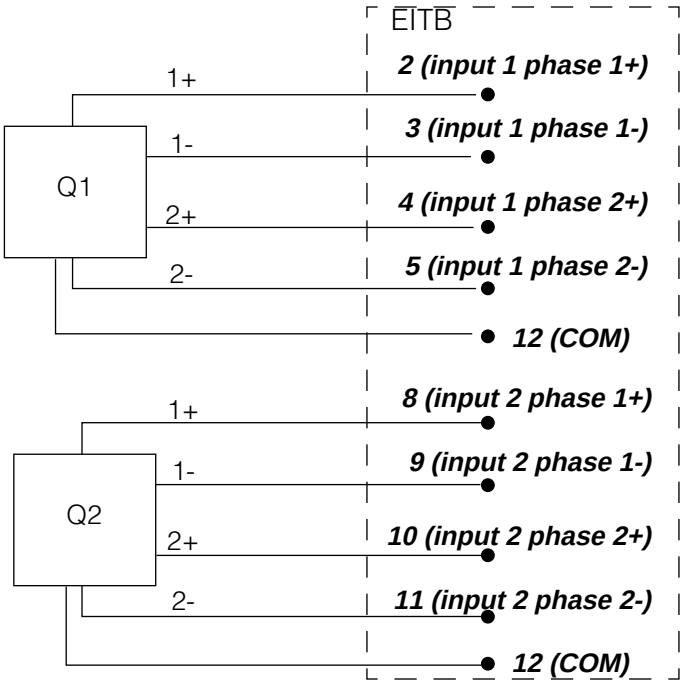


Figure 2.44 EITB Differential Quadrature Connections: Input 1 and 2 Shown

Encoder Connections without the EITB

Encoders may be connected directly to the PPC-2030 module. *Table 2.17* and *Table 2.19 on page 60* indicate the functional pinout for HD-15 connectors connected to the Encoder In Analog Out module connectors J1 and J2.

Table 2.18 HD-15 Encoder Signal Connections

Module I/O Number	Connector and Pin Number				AnaWin3 Name (Input Spreadsheet)[1]
	Phase 1		Phase 2		
	+	-	+	-	
Count 1 Frequency 1	J3-1	J3-2	J3-3	J3-10	PPC1:EIAO 11.1.1 C PPC1:EIAO 11.2.1 F
Count 2 Frequency 2	J3-6	J3-7	J3-8	J3-11	PPC1:EIAO 11.1.2 C PPC1:EIAO 11.2.2 F
Count 3 Frequency 3	J4-1	J4-2	J4-3	J4-10	PPC1:EIAO 11.1.3 C PPC1:EIAO 11.2.3 F
Count 4 Frequency 4	J4-6	J4-7	J4-8	J4-11	PPC1:EIAO 11.1.4 C PPC1:EIAO 11.2.4 F

[1] The AnaWin3 name is shown for the Encoder In Analog Out module with address 11 on the first PPC-2000 in the system. Refer to *Inputs on page 127* for a full explanation of analog input naming. Both count and frequency are measured for each input.

Table 2.19 HD-15 Power Connections

Voltage	Pin Number
+5Vdc	12, 15
COM	13, 14

Analog Output Connections

The connector pinouts are shown in *Table 2.20*. Use 16-28 AWG wire. When making connections, tighten to 0.5 to 0.6 Nm, or 4.5 to 5.4 inch-pound.

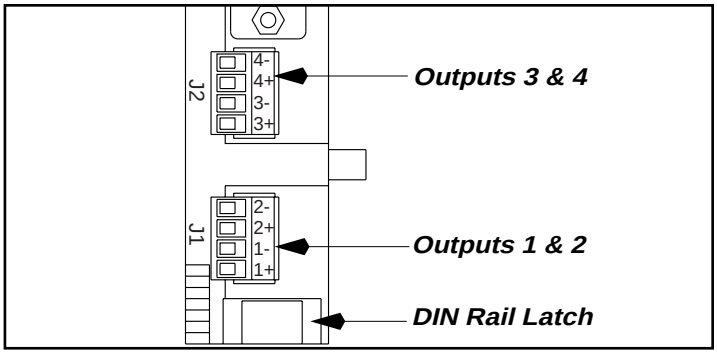


Figure 2.45 PPC-2030 Analog Out Terminal Block

Table 2.20 Analog Output Connections on Encoder In Analog Out Module

Module I/O Number	Encoder In Analog Out Module Connections		AnaWin3 Name (Input Spread-sheet)[1]
	+	-	
Analog Out 1	J1-1+	J1-1-	PPC1:EIAO 11.3.1
Analog Out 2	J1-2+	J1-2-	PPC1:EIAO 11.3.2
Analog Out 3	J2-3+	J2-3-	PPC1:EIAO 11.3.3
Analog Out 4	J2-4+	J2-4-	PPC1:EIAO 11.3.4

[1] The AnaWin3 name is shown for the Encoder In Analog Out module with address 11 on the first PPC-2000 in the system. Refer to *Outputs on page 135* for a full explanation of Analog output naming.

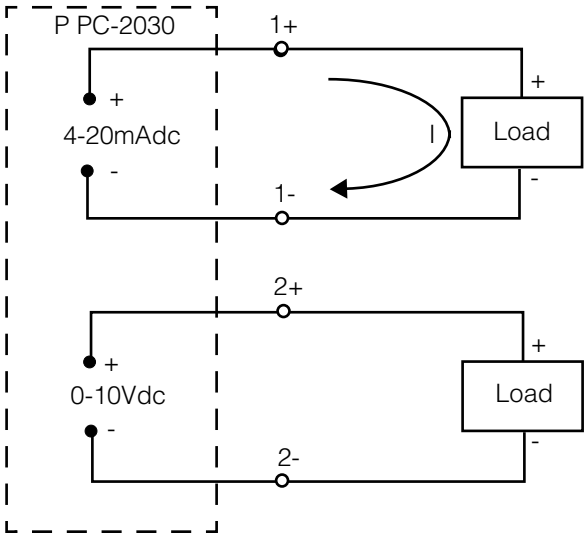


Figure 2.46 Analog Output Connections on a PPC-2030: Outputs 1 and 2 Shown

Connecting I/O to the PPC-2040

A TB50 connects to a PPC-2040 Digital I/O module through the 50 pin SCSI connector. Refer to *Figure 2.47 on page 62*. The terminal block interfaces to field wiring of the digital I/O (sensors, actuators, relays, SSRs, etc.).

Connecting the TB50 to the PPC-2040 Module

Refer to *Figure 2.47 on page 62*. Connect the SCSI connector from the PPC-2040 module to the TB50.

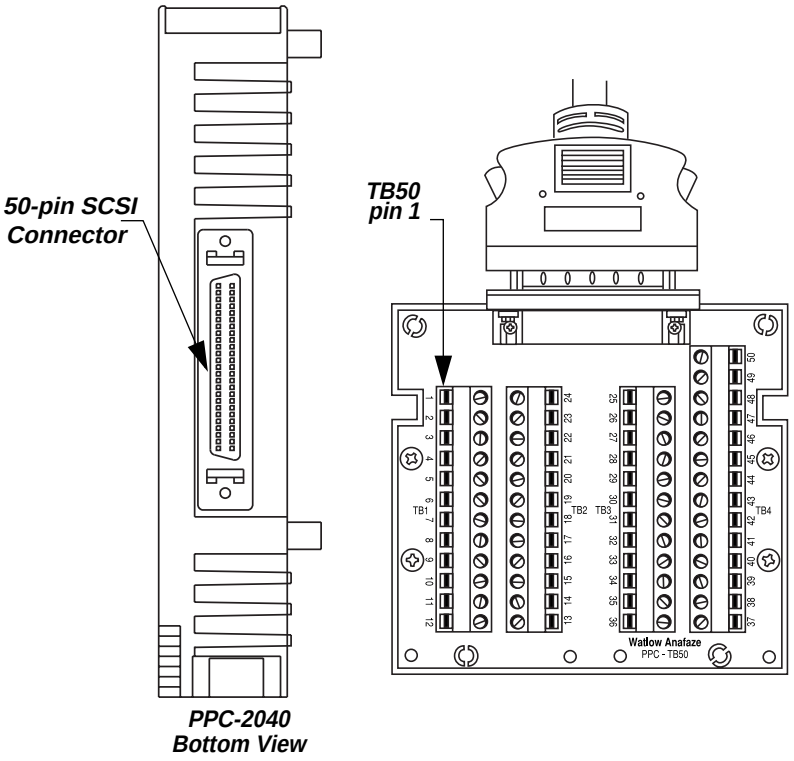


Figure 2.47 PPC-2040 Connection to TB50

NOTE! ***To avoid confusing the SCSI cables during servicing, label each end of each cable and each terminal board with the address of the module to which it should be connected.***

TB50 Connections

Connect digital inputs and digital outputs for control signals, alarms, and digital field I/O to the TB50. The PPC-2040 Digital I/O Module supports up to 32 digital inputs and outputs and up to two single-ended counter/frequency inputs. Counter inputs may be single-phase or quadrature. Connecting one single-phase counter or frequency signal uses one digital input. Connecting one quadrature input requires two digital inputs.

Table 2.21 on page 63 shows the TB50 pinout when used with the PPC-2040.

Use 14 to 22 AWG wire. When making connections, tighten to 0.5 to 0.6 Nm, or 4.5 to 5.4 inch-pound.

Table 2.21 Digital I/O Module Connections

Module I/O Number	TB-50 Terminal	AnaWin3 Name (Dig I/O Spreadsheet)[1]
Digital In/Out 1 Counter 1 Phase 1 Frequency 1	1	PPC1:DIO 21.0.1 PPC1:DIO 21.1.1 C[2] PPC1:DIO 21.2.1 F
Digital In/Out 2 Counter 1 Phase 2	2	PPC1:DIO 21.0.2 PPC1:DIO 21.1.1 C
Digital In/Out 3 Counter 2 Phase 1 Frequency 2	3	PPC1:DIO 21.0.3 PPC1:DIO21.1.2 C PPC1:DIO21.2.2 F
Digital In/Out 4 Counter 2 Phase 2	4	PPC1:DIO 21.0.4 PPC1:DIO21.1.2 C
Digital In/Out 5	5	PPC1:DIO 21.0.5
Digital In/Out 6	6	PPC1:DIO 21.0.6
Digital In/Out 7	7	PPC1:DIO 21.0.7
Digital In/Out 8	8	PPC1:DIO 21.0.8
Digital In/Out 9	9	PPC1:DIO 21.0.9
Digital In/Out 10	10	PPC1:DIO 21.0.10
Digital In/Out 11	11	PPC1:DIO 21.0.11
Digital In/Out 12	12	PPC1:DIO 21.0.12
Digital In/Out 13	13	PPC1:DIO 21.0.13
Digital In/Out 14	14	PPC1:DIO 21.0.14
Digital In/Out 15	15	PPC1:DIO 21.0.15
Digital In/Out 16	16	PPC1:DIO 21.0.16
Digital In/Out 17	17	PPC1:DIO 21.0.17
Digital In/Out 18	18	PPC1:DIO 21.0.18
Digital In/Out 19	19	PPC1:DIO 21.0.19
Digital In/Out 20	20	PPC1:DIO 21.0.20
Digital In/Out 21	21	PPC1:DIO 21.0.21
Digital In/Out 22	22	PPC1:DIO 21.0.22
Digital In/Out 23	23	PPC1:DIO 21.0.23
Digital In/Out 24	24	PPC1:DIO 21.0.24
Digital In/Out 25	25	PPC1:DIO 21.0.25
Digital In/Out 26	26	PPC1:DIO 21.0.26
Digital In/Out 27	27	PPC1:DIO 21.0.27
Digital In/Out 28	28	PPC1:DIO 21.0.28
Digital In/Out 29	29	PPC1:DIO 21.0.29
Digital In/Out 30	30	PPC1:DIO 21.0.30
Digital In/Out 31	31	PPC1:DIO 21.0.31
Digital In/Out 32	32	PPC1:DIO 21.0.32
Com (DC Common for Input Return)	37 to 50	N/A

1. The AnaWin3 name is shown for the first Digital I/O module on the PPC-2000 system. See *Digital I/O on page 132* for a complete explanation of digital I/O names.

2. Both count and frequency are measured for the pulse input. See *Inputs on page 127* for an explanation of analog input names.

Connecting Digital Inputs

The PPC-2040 module can accept digital inputs. When the resistance of an input device is 27 kOhm or greater, the input is considered off by the PPC-2000. When the resistance is 1 kOhm or less, the input is considered on.

To install a switch as a digital input, connect one lead to the DC Common input return on the TB50. Connect the other lead to the desired digital input on the TB50. Refer to *Table 2.21 on page 63* for screw terminal numbering.

Use the Digital I/O parameters to configure digital inputs. Refer to *Digital I/O on page 132*.

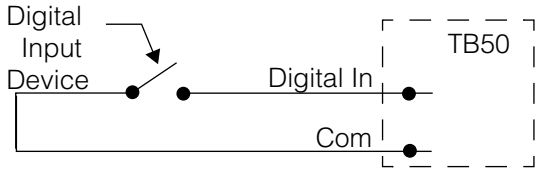


Figure 2.48 Wiring Digital Inputs

Connecting Counter or Frequency Inputs

A PPC-2040 module accepts single-phase or quadrature pulse signals from devices such as encoders. Counts and frequencies of the inputs may be scaled with user selectable parameters. See *Setting up User Selectable Linear Inputs on page 98* for more information.

The PPC-2040 module can accommodate encoder signals up to 24Vdc. The following figures illustrate connecting encoders:

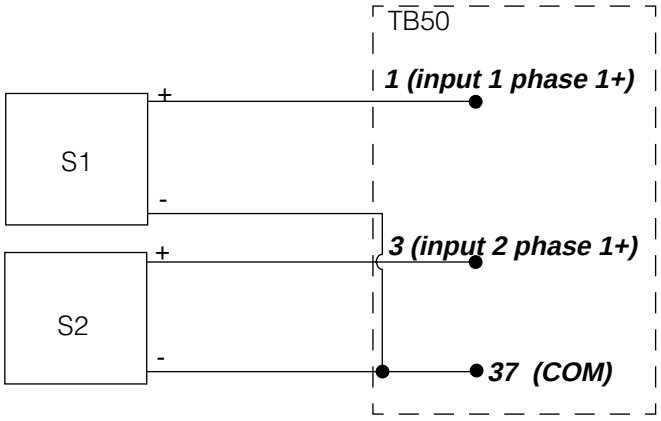


Figure 2.49 Single Phase Connections: Input 1 and 2 Shown

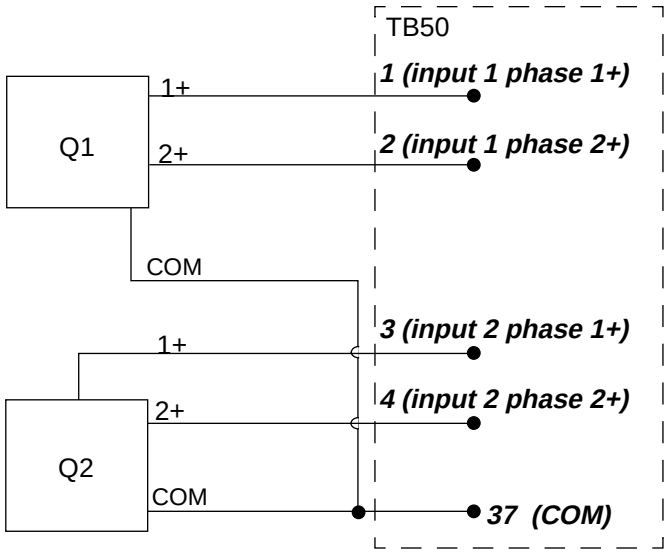


Figure 2.50 Quadrature Connections: Inputs 1 and 2 Shown.

Connecting Digital Outputs

The digital outputs sink current from a load connected to the controller's power supply, or another power supply referenced to the PPC-2000 power common. Do not exceed +24 volts.

If you must tie the external load to ground, or if you cannot connect it as shown in *Figure 2.51 through Figure 2.53*, use a solid state relay to drive your load.

The outputs conduct current when they are LOW or ON. The maximum current sink capability is 150mA at 24Vdc. They cannot 'source' current to a load.

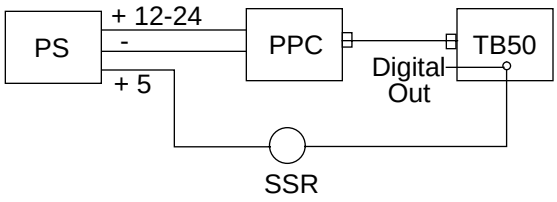


Figure 2.51 Powering Output with 5Vdc from PPC Supply

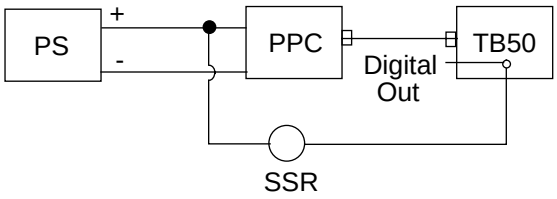


Figure 2.52 Powering Output with 12-24Vdc from PPC supply

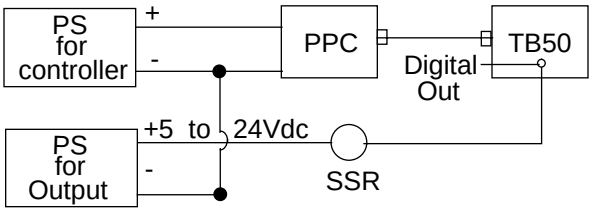


Figure 2.53 Powering Output with Separate Power Supplies

Connecting Analog Outputs to the PPC-205x

Connect wires directly to the terminals on the bottom of the PPC-205x modules. The PPC-2050 can source up to eight analog signals and the PPC-2051 up to four.

Table 2.22 lists the terminal connections for the PPC-2050 module.

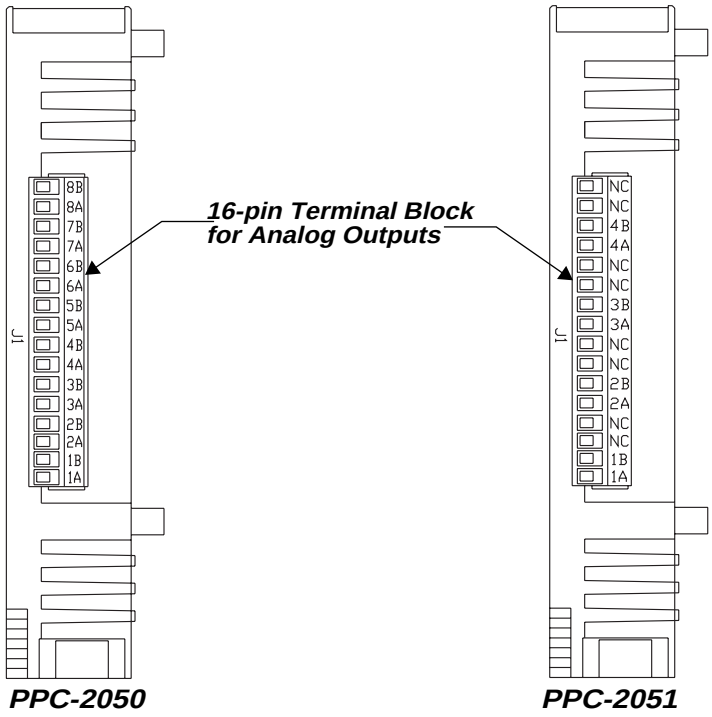


Figure 2.54 PPC-205x Connections (Bottom View)

Table 2.22 Analog Output Connections on Analog Out Module

Module I/O Number	Analog Out Module Connections				AnaWin3 Name (Input Spreadsheet)[1]
	Voltage		Current		
	+	-	Source	Sink	
Analog Out 1	1A	1B	1B	1A	PPC1:AO 31.1
Analog Out 2	2A	2B	2B	2A	PPC1:AO 31.2
Analog Out 3	3A	3B	3B	3A	PPC1:AO 31.3
Analog Out 4	4A	4B	4B	4A	PPC1:AO 31.4
Analog Out 5	5A	5B	5B	5A	PPC1:AO 31.5
Analog Out 6	6A	6B	6B	6A	PPC1:AO 31.6
Analog Out 7	7A	7B	7B	7A	PPC1:AO 31.7
Analog Out 8	8A	8B	8B	8A	PPC1:AO 31.8

1. The AnaWin3 name is shown for the Encoder In Analog Out module with address 11 on the first PPC-2000 in the system. Refer to *Outputs on page 135* for a full explanation of Analog output naming.

NOTE! ***On the PPC-2050, each consecutive pair of analog outputs—1-2, 3-4, 5-6 and 7-8—shares an internal power supply. In current mode the power supply + is shared, and in voltage mode the common is shared. If an external power supply is tied into the internal power supply though the B pin, the signal to each output may be distorted. It may be necessary to use a separate external power supply for each analog output within the pair. Each output on the PPC-2051 has a separate internal power supply so the same external power supply may be used.***

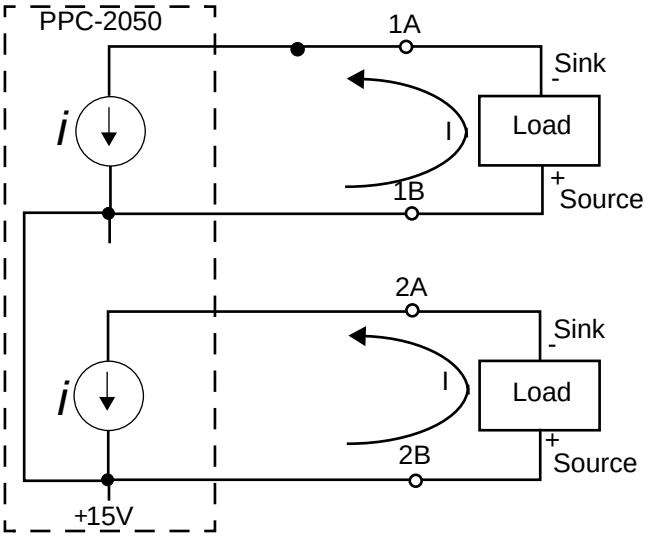


Figure 2.55 Analog Output Connections on a PPC-2050 Configured for Current: Outputs 1 and 2 Shown

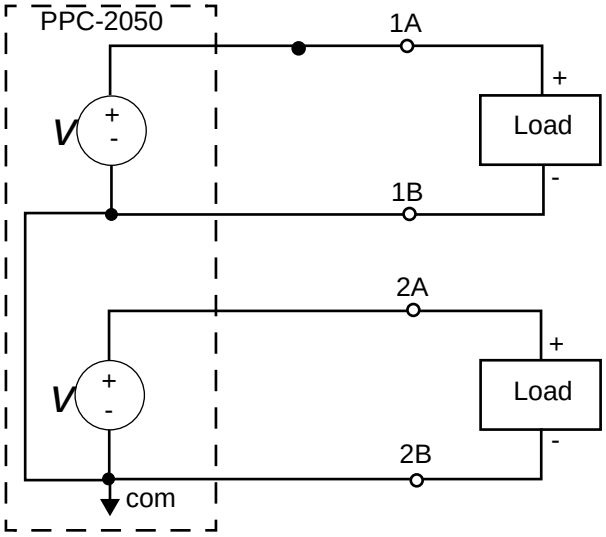


Figure 2.56 Analog Output Connections on a PPC-2050 Configured for Voltage: Outputs 1 and 2 shown

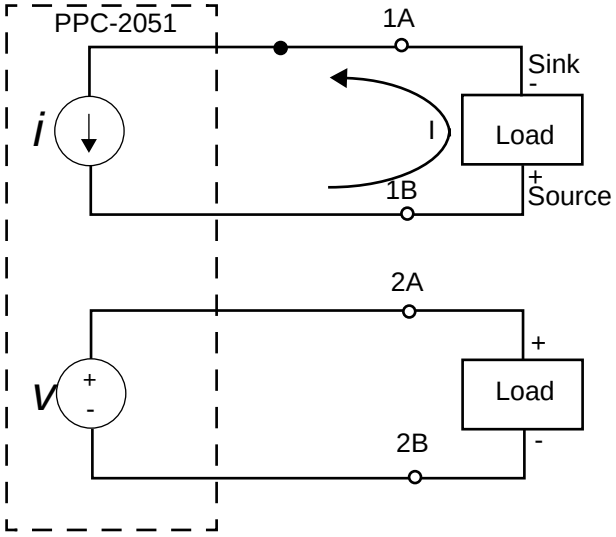


Figure 2.57 Analog Output Connections on a PPC-2051 Configured for Current and Voltage: Outputs 1 and 2 shown

NOTE! ***The B terminal sources current and the A terminal sinks it on outputs configured for current. On outputs configured for voltage the A terminal is at the greater potential.***

Connecting to the Relay Outputs on the PPC-206x

The PPC-2061 and PPC-2062 provide connections located on the bottom panel for eight electromechanical relay outputs and three counter inputs. Relay output field wiring is terminated at a sixteen position removable terminal block.

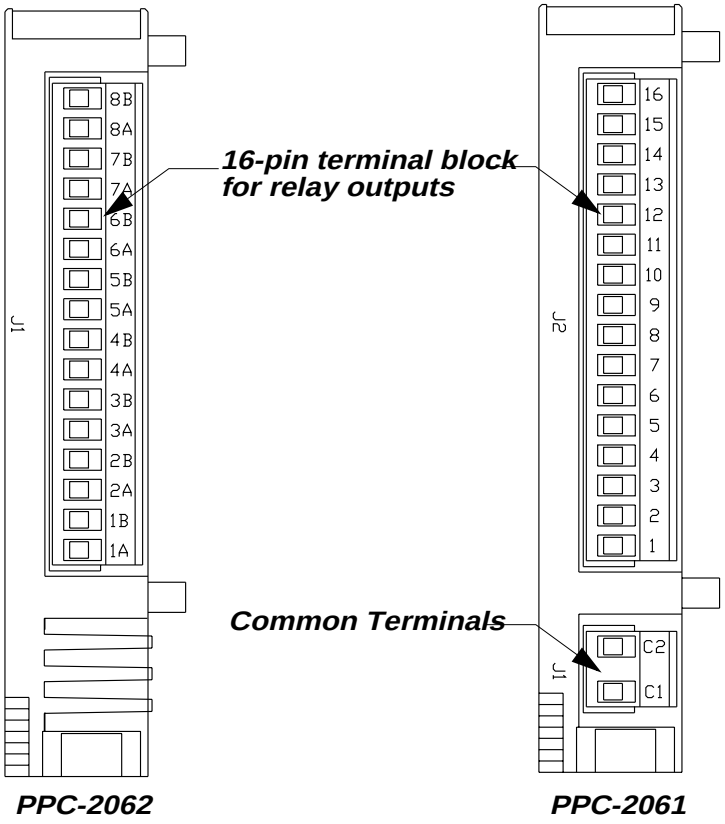


Figure 2.58 PPC-206x Connections (bottom view)

Wiring PPC-2061 Relay Outputs

The PPC-2061 has 16 normally open relay outputs. Outputs 1 to 8 share one common, and outputs 9-16 share the second common. Either AC or DC may be switched. See *Figure 2.59* for an example of how to connect to the relay outputs.

Table 2.23 on page 72 lists the connections to the PPC-2060 and PPC-2061 modules.

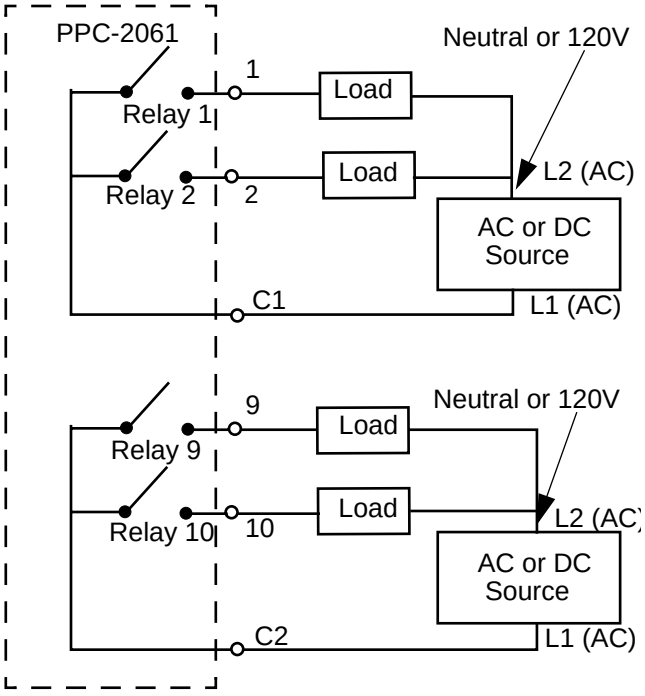


Figure 2.59 Relay Output Connections on a PPC-2061: Outputs 1, 2, 9 and 10 shown

WARNING! ***Do not switch AC neutral (L2). Load switching must occur on the hot (L1) side of the AC line. Failure to do so could cause injury or death.***

Wiring PPC-2062 Relay Outputs

The PPC-2062 has eight normally open, single-contact relay outputs. The load may be connected to either contact. DC or AC power may be switched. See *Figure 2.60 on page 72* for an example of how to connect to the relay outputs.

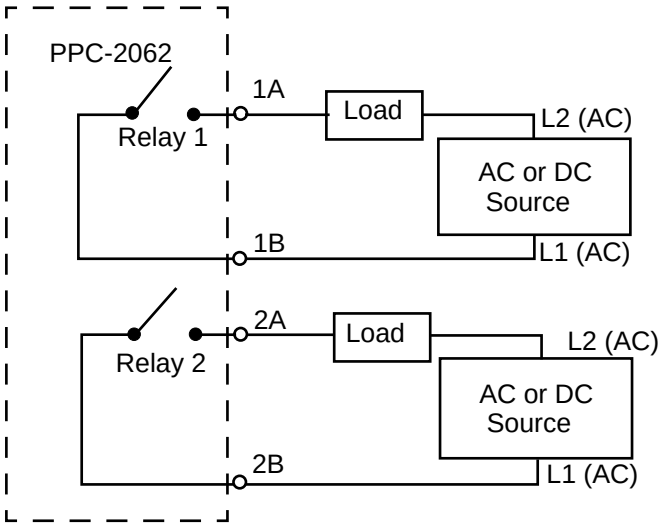


Figure 2.60 Relay Output Connections on a PPC-2062: Outputs 1 and 2 Shown

Table 2.23 Relay Output Connections on PPC-206x Digital Output Modules

Module I/O Number	Digital Out Module Connections				AnaWin3 Name (Dig I/O Spread-sheet)[1]
	PPC-2061		PPC-2062		
	Out	Com			
Digital Out 1	1	C1	1A	1B	PPC1:DO 41.1
Digital Out 2	2	C1	2A	2B	PPC1:DO 41.2
Digital Out 3	3	C1	3A	3B	PPC1:DO 41.3
Digital Out 4	4	C1	4A	4B	PPC1:DO 41.4
Digital Out 5	5	C1	5A	5B	PPC1:DO 41.5
Digital Out 6	6	C1	6A	6B	PPC1:DO 41.6
Digital Out 7	7	C1	7A	7B	PPC1:DO 41.7
Digital Out 8	8	C1	8A	8B	PPC1:DO 41.8
Digital Out 9	9	C2	n/a	n/a	PPC1:DO 41.9
Digital Out 10	10	C2	n/a	n/a	PPC1:DO 41.10
Digital Out 11	11	C2	n/a	n/a	PPC1:DO 41.11
Digital Out 12	12	C2	n/a	n/a	PPC1:DO 41.12
Digital Out 13	13	C2	n/a	n/a	PPC1:DO 41.13
Digital Out 14	14	C2	n/a	n/a	PPC1:DO 41.14
Digital Out 15	15	C2	n/a	n/a	PPC1:DO 41.15
Digital Out 16	16	C2	n/a	n/a	PPC1:DO 41.16

[1] The AnaWin3 name is shown for the Digital Out module with address 41 on the first PPC-2000 in the system. See *Digital I/O on page 132* for a full explanation of Digital I/O naming.

Using Snubbers for Relay Outputs

Relay contacts can arc and/or generate EMI. Over time, arcing will shorten the life of relay contacts and EMI can disrupt system functions. Use snubbers—a resistor and capacitor in series— to protect against EMI and lengthen relay life.

The capacitor should be non-polarized and may be metallized polyester film or metallized polypropylene and the voltage rating must be 600Vdc/250Vac. The resistor may be carbon composition or carbon film. It should be 0.5 or 1 watt with 5% tolerance. Use 1 watt if the contacts are used in a rapid cycling application.

The following values are acceptable for most applications using the PPC-2061 and PPC-2062 relay output modules:

- Resistor: 120 Ω
- Capacitor: 0.47 µF

Install the snubber across the contacts or the load. Generally, it performs more reliably across the contacts.

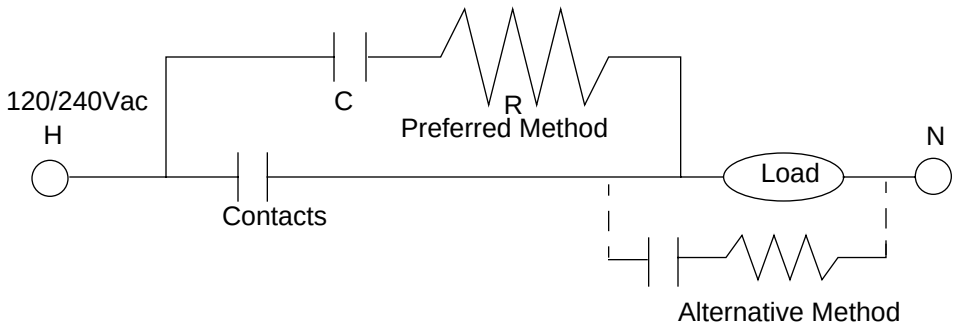


Figure 2.61 Snubber Connections

Connecting Digital Inputs to the PPC-207x

Connect wires directly to the terminals on the bottom of the PPC-207x modules. Up to 16 inputs are accommodated. Depending on the module type, DC and AC inputs are accommodated.

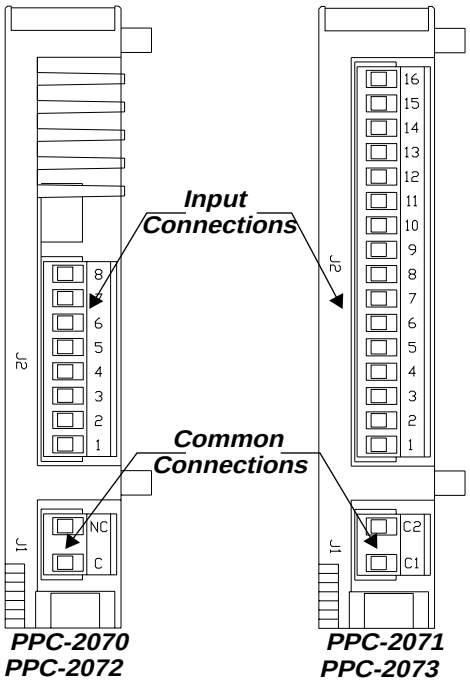


Figure 2.62 PPC-207x Connections (bottom view)

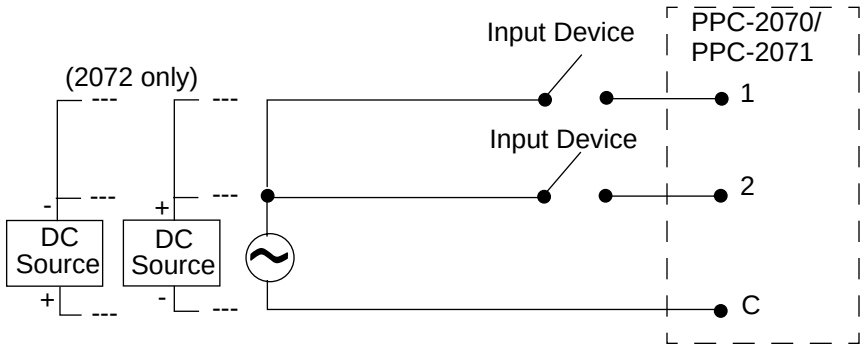


Figure 2.63 Input Connections to a PPC-2070 or PPC-2072: Inputs 1 and 2 shown

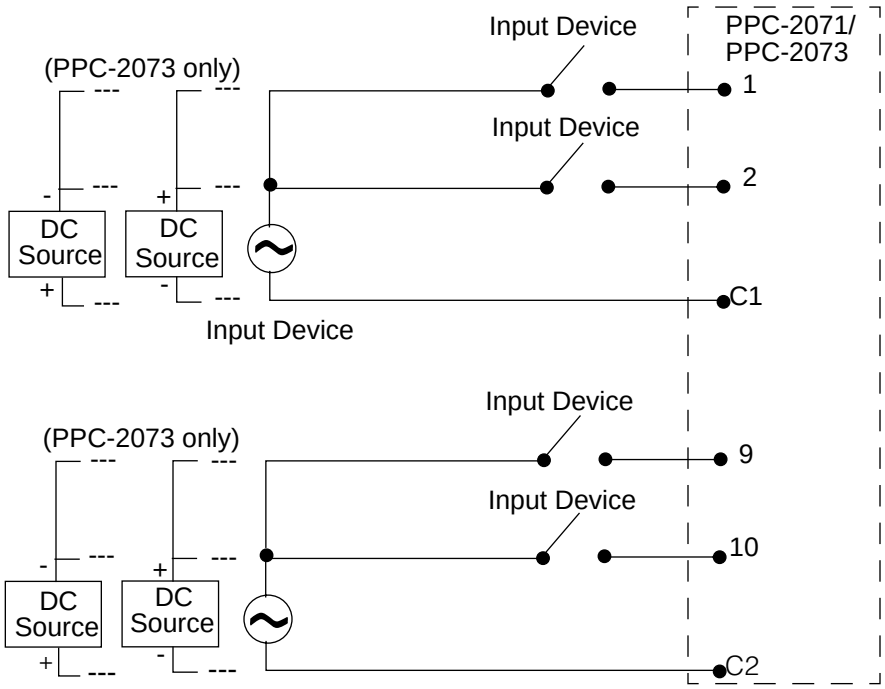


Figure 2.64 Input Connections to a PPC-2071 or PPC-2073: Inputs 1,2, 9 and 10 Shown

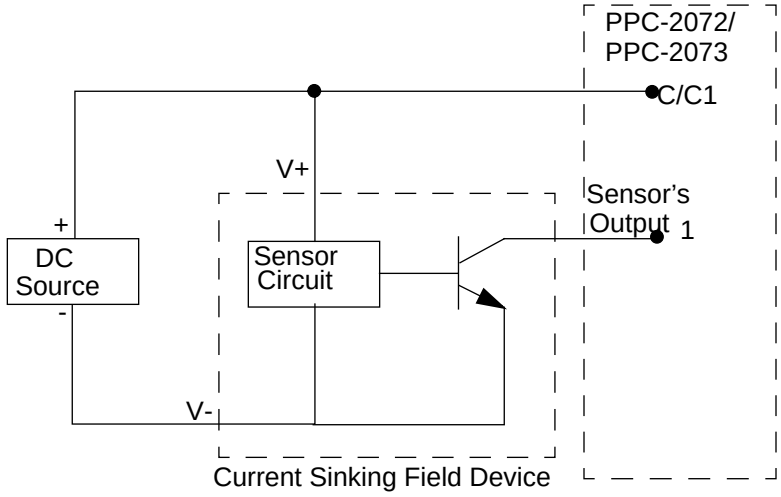


Figure 2.65 Connecting a Current Sinking Field Device to a PPC-2072 or PPC-2073: Input 1 Shown

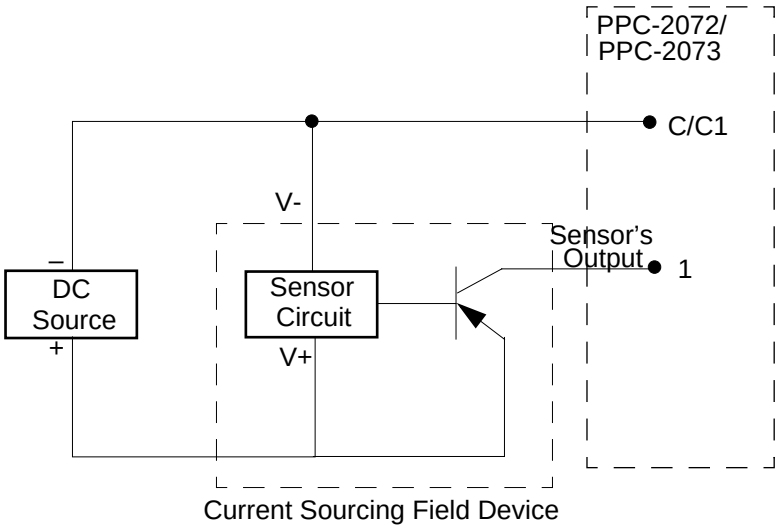


Figure 2.66 Connecting a Current Sourcing Field Device to a PPC-2072 or PPC-2073: Input 1 Shown

Table 2.24 Digital Input Connections on PPC-207x Modules

Module I/O Number	Digital In Module Connections				AnaWin3 Name (Dig I/O Spreadsheet)[1]
	PPC-2070 PPC-2072		PPC-2071 PPC-2073		
	Input	Com	Input	Com	
Digital In 1	1	C	1	C1	PPC1:DI 51.1
Digital In 2	2	C	2	C1	PPC1:DI 51.2
Digital In 3	3	C	3	C1	PPC1:DI 51.3
Digital In 4	4	C	4	C1	PPC1:DI 51.4
Digital In 5	5	C	5	C1	PPC1:DI 51.5
Digital In 6	6	C	6	C1	PPC1:DI 51.6
Digital In 7	7	C	7	C1	PPC1:DI 51.7
Digital In 8	8	C	8	C1	PPC1:DI 51.8
Digital In 9	n/a	n/a	9	C2	PPC1:DI 51.9
Digital In 10	n/a	n/a	10	C2	PPC1:DI 51.10
Digital In 11	n/a	n/a	11	C2	PPC1:DI 51.11
Digital In 12	n/a	n/a	12	C2	PPC1:DI 51.12
Digital In 13	n/a	n/a	13	C2	PPC1:DI 51.13
Digital In 14	n/a	n/a	14	C2	PPC1:DI 51.14
Digital In 15	n/a	n/a	15	C2	PPC1:DI 51.15
Digital In 16	n/a	n/a	16	C2	PPC1:DI 51.16

[1] The AnaWin3 name is shown for the Digital In module with address 51 on the first PPC-2000 in the system. See *Digital I/O on page 132* for a full explanation of digital I/O output naming.

Connecting Power

PPC-IPS-2 Power Supply

The PPC-IPS-2 accepts two ranges of voltages. Connections are made at screw terminals.

Table 2.25 PPC-IPS-2 Voltage Input Switch Settings

IPS-2 Switch Setting	Input Voltage Range	Input Frequency
115V	88-132Vac	47-440Hz
230V	176-264Vac	

CAUTION! ***The PPC-IPS-2 accepts two ranges of voltage. Be sure to set the switch to the appropriate range before applying power.***

Processor Module

The processor module accepts 10 to 28Vdc. Connect the terminal labeled +V on the PPC-2010 to the DC power and the terminal labeled C to the DC common. See *Table 2.26* for connections for the two power supplies.

Table 2.26 Power Supply Connections

PPC-2010	IPS-2
+V	V2
C	COM

Figure 2.67 on page 78 illustrates the connections when using the PPC-IPS-2.

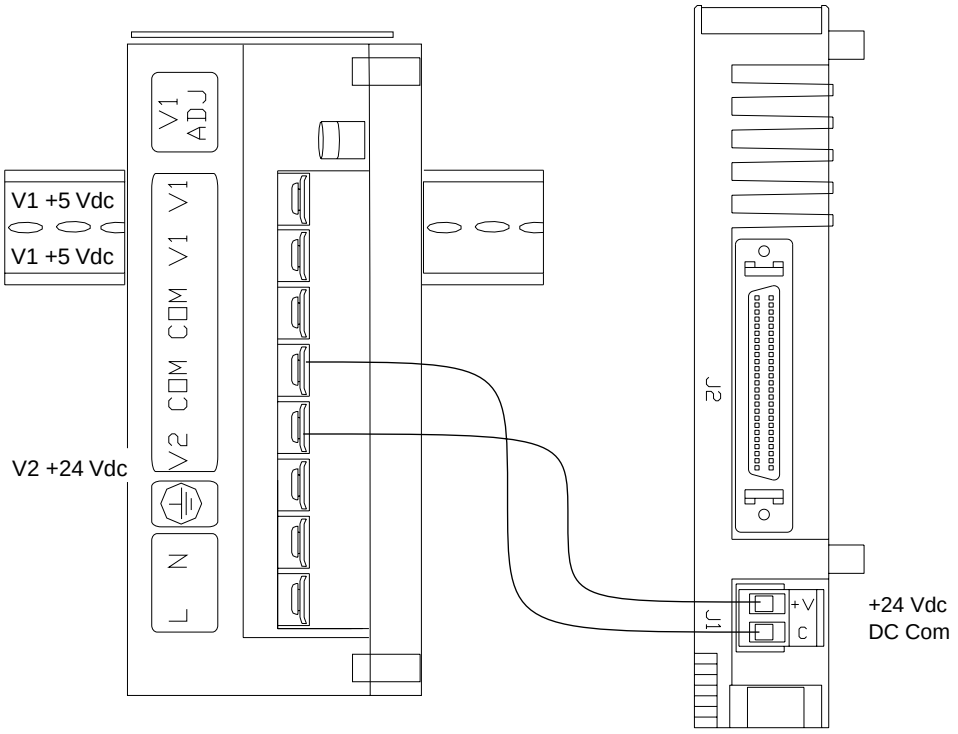


Figure 2.67 PPC-IPS-2 Power Connections

Connecting Communication Ports

Communications ports 1 and 2 on the PPC-2010 Processor module may be used to communicate with an operator interface terminal, a computer running *AnaWin3, LogicPro*, or third-party software, or any device capable of acting as a host using the Modbus RTU protocol.

PPC controllers always act as servers or slaves. The computer or other host device must act as the client or master.

Communication Ports

Both communication ports support RS-232 and RS-485 signals. A 4-position, 4-conductor telephone handset connector is provided for RS-232 communications and an RJ12 connector is provided for RS-485 communications. Only one of these connectors may be used. Both ports are optically isolated.

Communication Cables

Watlow Anafaze supplies flat, oval cables with modular plug and DB-9 connectors for RS-232. RS-485 cables have RJ12 connectors and bare-wire ends. These cables may be used for short runs between a PPC and a host device or between a PPC and a terminal strip or other wiring interface. When using other cables or connecting over longer distances, select cables and connectors that meet the standards described in this section.

Do not use cables from sources other than Watlow Anafaze unless the shield wire is in the proper position (pin 6) in the connector. *Table 2.27* and *Table 2.28 on page 80* describe the pin outs for the two connector types.

Cable Connector Pin Outs

Cable connectors must have the correct pin outs.

Refer to *Figure 2.68 on page 79* to determine the location of pin 1 in the connectors. Refer to *Table 2.27 on page 79* for RS-232 cable pin outs. Refer to *Table 2.28 on page 80* for the RS-485 pin out and connections. The colors in the table are for Watlow Anafaze cables.

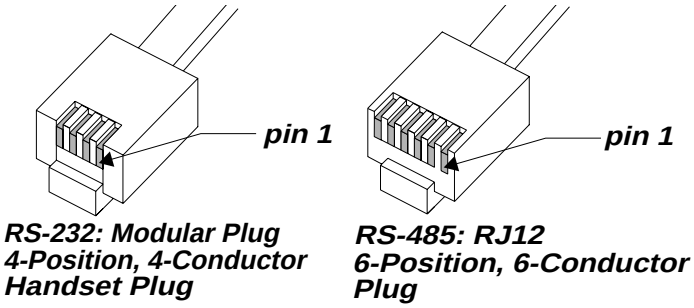


Figure 2.68 RS-232 and RS-485 RJ-Type Connectors

Table 2.27 RS-232 Connector Pin Outs

Plug Pin #	Wire Color	PPC Function	DB9 Pin #	DB25 Pin #
1	Black	Common	5	7
2	Red	R	3	2
3	Green	T	2	3
4	Bare (Shield)	Frame Ground	N/C	N/C

Table 2.28 RS-485 Connector Pin Out and Connections

RJ12 Pin #	Wire Color	PPC Function	Converter Connection
1	White or Blue	Common	Common
2	Black	RB	TXB/TDB/TX+
3	Red	TB	RXB/RDB/RX+
4	Green	TA	RXA/RDA/RX-
5	Yellow	RA	TXA/TDA/TX-
6	Bare (Shield)	not used	N/C

Jumpers in RS-232 Connectors

Some software programs and some operator interface terminals require a Clear to Send (CTS) signal in response to their Request to Send (RTS) signal, or a Data Set Ready (DSR) in response to their Data Terminal Ready (DTR). The PPC-2000 is not configured to receive or transmit these signals. To use such software with the PPC, jumper RTS to CTS and DTR to DSR in the DB connector. *Table 2.29* lists the standard pin assignments for DB-9 and DB-25 connectors.

Table 2.29 RTS/CTS Pins in DB-9 and DB-25 Connectors

	DB-9	DB-25
RTS	7	4
CTS	8	5
DTR	4	20
DSR	6	6

Cables manufactured by Watlow Anafaze for RS-232 communications include these jumpers. *AnaWin3* and *LogicPro* do not require these jumpers and are not affected by their presence.

Connecting RS-232 Communications

RS-232 may be used for communications between one PPC and a host device over cables of up to 50 feet in length.
RS-232 does not support more than two devices on a network. See *Figure 2.69*. RS-232 may be used to connect a computer, through a 232/485 converter, to an RS-485 communications network with up to 32 PPC controllers. See *Figure 2.70*.

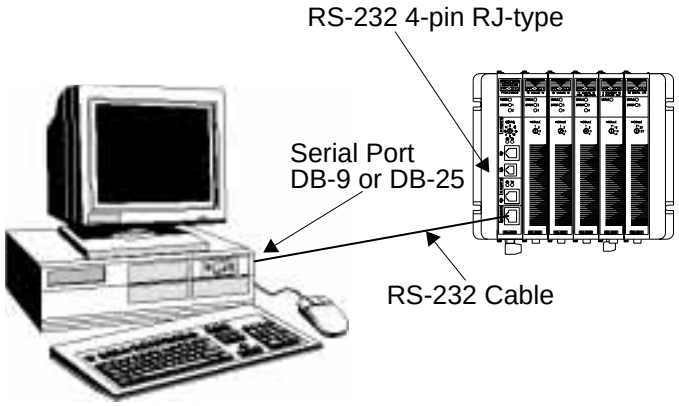


Figure 2.69 Connecting One PPC to a Computer Using RS-232

Connecting RS-485 Communications

An RS-485 communications network can connect up to 32 PPCs directly with a host device equipped with an RS-485 port or via a converter to a host's RS-232 port. See *Figure 2.70*. RS-485 wiring can be used over much greater distances than RS-232.

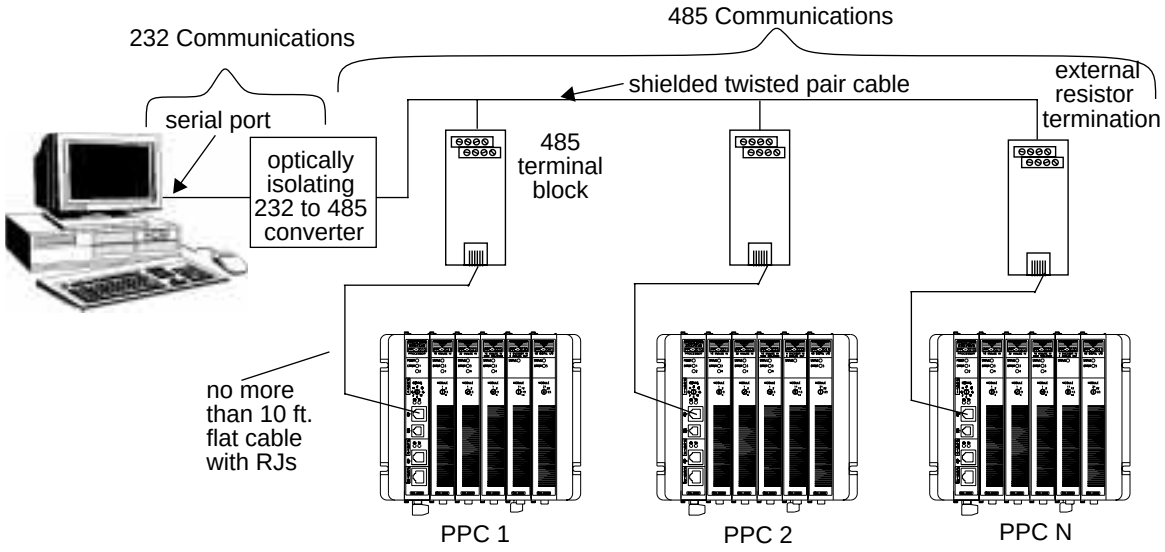


Figure 2.70 Connecting Multiple PPCs to a Computer Using RS-485

The host computer uses one twisted pair to send messages to any PPC on the network. All the PPCs receive all the messages. The one PPC addressed by a particular message uses the other twisted pair to respond. This twisted pair is shared by the transmitters of all the PPCs on the network. Only one PPC transmits at a time.

Therefore, one twisted pair connects the transmitter terminals at the host computer or converter to the receivers on each of the controllers. The second twisted pair connects the computer or converter's receiver to the transmitters on all the PPCs on the network. *Figure 2.71* illustrates this.

Network wiring should approximate a daisy chain as closely as possible. Keep the distance from the point at which the wires are split to the PPC as short as possible. Long spurs can cause destructive interference of the signals.

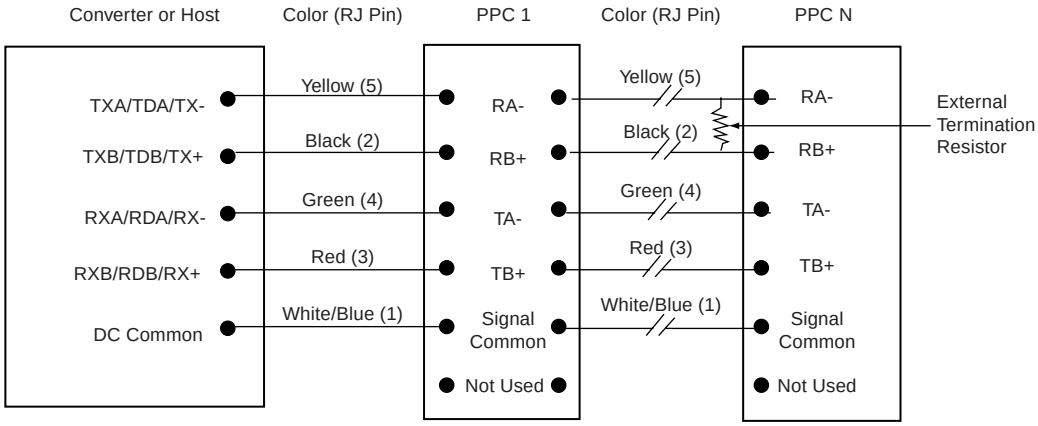


Figure 2.71 RS-485 Wiring

485 Terminal Block

The 485 terminal block accepts an RJ12 cable connector and converts each line on the cable to a screw terminal. Use the 485 terminal block to wire multiple PPC-2000 controllers together on the same 485 network. Pins on the terminal block are designated 1 to 6. The function and number of each pin corresponds to the function and pin numbers of the 485 ports on the PPC-2010 module.

Table 2.30 485 Terminal Block Pin Assignment

485 Terminal Block Pin Number	PPC-2010 485 Port Pin Number	Function
1	1	Common
2	2	RB +
3	3	TB +
4	4	TA -
5	5	RA -
6	6	Not used
S	Not used	Not used

Cable Recommendations

Watlow Anafaze recommends Belden #9843 or its equivalent. This cable includes three, 24 AWG, shielded, twisted pairs. It should carry signals of up to 19.2 kbaud with no more than acceptable losses for up to 4000 feet.

RS-485 Network Connections

Run twisted pair from the host or converter to a 485 terminal block as close to first PPC as possible, and from that point to another 485 terminal block near the next PPC, and so on. Connect 485 terminal blocks in series using appropriate lengths of 485 cable. Be sure to connect all five conductors at each junction such that the 485 terminal block at each PPC will see the same signals on each of its pins.

Install the 485 terminal blocks as close to each PPC as possible. To avoid unacceptable interference, use less than ten cable feet from the terminal to the PPC serial port.

Use cables with RJ12 plugs to connect from the 485 terminal blocks to the serial ports on each PPC-2010, or use cables with bare wires on one end and RJ12 connectors on the other to connect from terminal strips to the PPCs.

Two Wire RS-485 Connections

By placing jumpers between the (+) pins and between the (-) pins on the 485 terminal blocks, RS-485 systems may be configured for two wire connections as well. Use the same cables with RJ12 plugs as you would use for four wire connections to connect from the 485 terminal blocks to the serial ports on each PPC-2010. Connect the two wire RS-485 network to the 485 terminal block according to *Figure 2.72*.

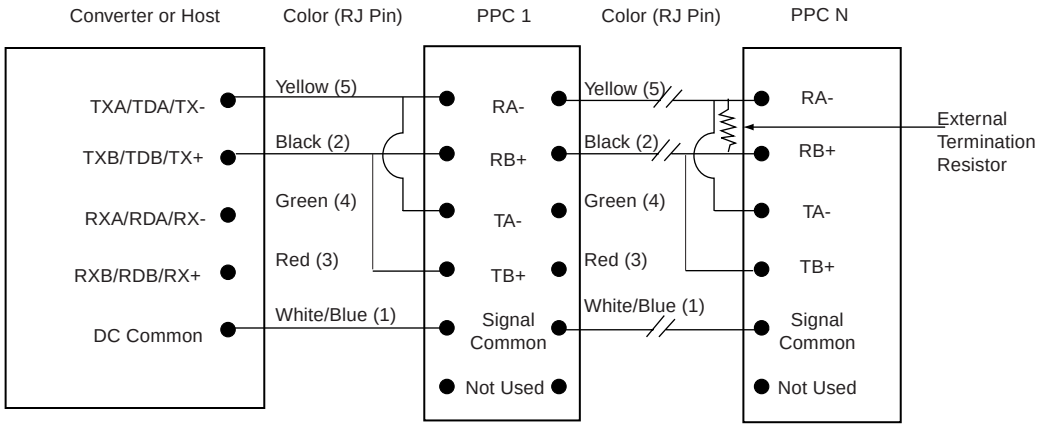


Figure 2.72 Two Wire RS-485 Wiring

PPCs Mounted Close Together

In installations where two or more PPCs are close enough together that using terminal strips or modular jack junction boxes would result in greater lengths of flat cable than the distance between the communications ports use modular jack splitters and flat oval cables with RJ12 connectors on both ends. See *Figure 2.73*.

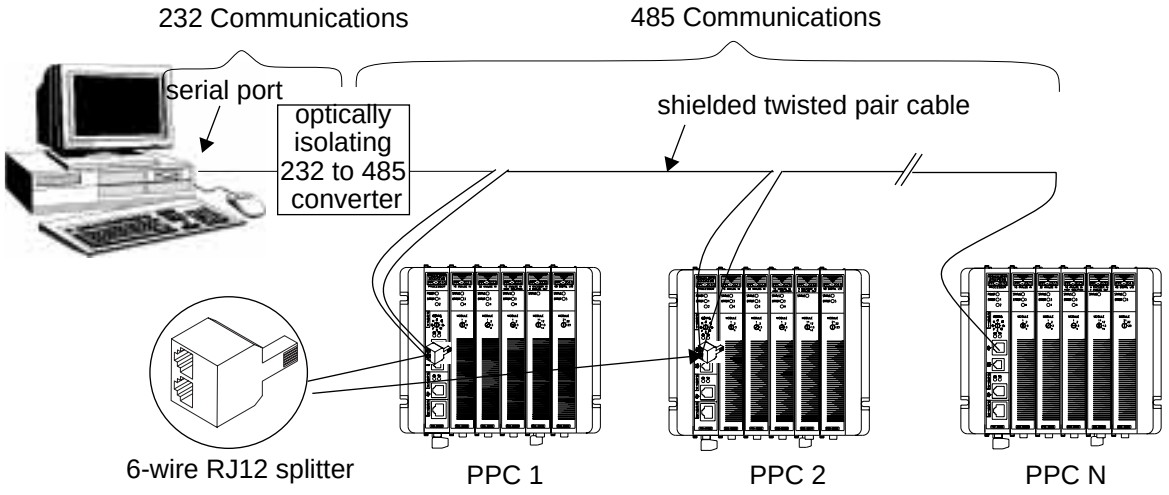


Figure 2.73 Connecting Several PPCs with Short Cable Runs

Signal Common

Each controller and the converter should be connected to the signal common to insure they can properly interpret the signals on the network. Pin #1 in the RJ12 connectors connects the signal commons of all the PPCs to each other. At the converter connect the signal common to the common of the converter's DC power supply.

The communications ports are optically isolated from the sensors and the rest of the PPC circuitry, so connecting the communications commons together will not create a ground loop.

Termination

In some installations, particularly when transmission lines are long, the transmission lines must be terminated. The receive lines at the converter or host device should be terminated in the converter, the connector to the host device, or the device itself. Typically the converter documentation provides instructions for termination.

The PPC receive lines can be terminated by setting a jumper on the last PPC-2010 module. To terminate the lines for port 1, set jumper JU1 on the last PPC-2010 module on the network to the A position. This places a 120 ohm resistor across the receive lines. To terminate the line for port 2, set jumper JU2 on the last PPC-2010 module on the network to the A position. This places a 120 ohm resistor across the receive lines. See *PPC-2010 Jumper Settings on page 18*.

Alternately, the line may be terminated externally on the 485 terminal block by placing a termination resistor across the receive line screw terminals near the last PPC. See *Figure 2.70 on page 81*. The value of the termination resistor should be equal to the impedance of the communications cable used. Values are typically 120 to 200 ohm.

Modbus Network Address

For multiple PPC installations, each PPC-2010 must have a unique network address. As many as 32 PPC systems may communicate on a network. Both port 1 and 2 have the same network address. Network addresses 1 through 4 can be set using the rotary switch on the processor module.

Changed communication parameters do not take affect until the controller resets or cycles power, and only with the appropriate rotary switch settings on the Processor module.

Use rotary switch setting **D** and *PPCComSu* to program the remaining addresses (5-32). See *Setting Programmable Modbus Addresses on page 87* for programming information.

NOTE! ***Do not cycle power with the rotary switch set in positions E-G unless specifically directed to do so. These positions are used for clearing memory and other functions. Parameter settings can be lost. See Chapter 4, Troubleshooting, for more on these switch settings.***

Table 2.31 PPC-2010 Rotary Switch Configuration

Position	Network Address
A	Fixed: 1
B	Fixed: 2
C	Fixed: 3
D	Programmable, Default: 4
E-G	N/A
H	Fixed: 1

Switch positions **A-D** select the following settings:

- 19.2 kbaud (programmable)
- Even parity (fixed)
- 8 data bits (fixed)
- 1 stop bit (fixed)

Switch position **H** selects the following fixed settings:

- 19.2 kbaud
- Even parity
- 8 data bits
- 1 stop bit

Switch settings **E-G** are reserved.

Setting Programmable Modbus Addresses

Modbus addresses one through four may be set using the rotary switch on the face of the PPC-2010 Processor Module. See *Modbus Network Address on page 86* for information on setting the rotary switch. The following procedure describes how to set other addresses:

WARNING! ***Power is shut off to the PPC during the following procedure. Power cycling will interfere with process control. Do not perform this procedure if interrupting process control is not acceptable.***

1. Close *AnaWin3* and *LogicPro* if either is running.
2. Connect only the PPC to be configured to the computer on which *AnaWin3* is installed.
3. Set the rotary switch on the Processor Module to position **H**.
4. Turn off power to the PPC system.
5. Turn power on to the PPC system.
6. Launch *PPCComSu*.
7. Select the desired **Baud Rate** for each port.
8. Select the desired Modbus address for the PPC system.
9. Click the **Send** button.
10. Close *PPCComSu*.
11. Set the rotary switch on the Processor Module to position **D**.
12. Turn off power to the PPC system.
13. Turn on power to the PPC system.

Once configured with unique addresses, as many as 32 PPC controllers may be connected to the PC on a 485 communications network.

3

Operating with AnaWin3

This section describes how to use your PPC system with *AnaWin3*, the Watlow Anafaze HMI software. For hardware installation and configuration information, refer to *Chapter 2, Hardware Installation*. For *AnaWin3* installation and user information, refer to the *AnaWin3 User's Guide*.

Type Definitions

In the following sections, a special font or typeface is used to indicate text seen on the *AnaWin3* screens:

LP Enable
Set this field to enable or disable the low process alarm. When it is Enabled, the low process alarm activates if the process variable (PV) dips below the **LP Limit.** The PV must rise above the **LP Limit** plus the alarm deadband to be reset (cleared). When this parameter is set to Disabled, the low process alarm

Figure 3.1 Sample Screen Text

The words **LP Enable** and **LP Limit** are shown as they appear in *AnaWin3*.

Closed-Loop Control

The PPC-2000 closed-loop control program can control up to 48 channels. *Closed-loop control* refers to the control of an output based on feedback from a sensor or other signal.

Feedback

Electrical signals from a sensor used to determine a control output is feedback. The Input parameters determine how the electrical signal is interpreted. Many standard sensor types are pre-programmed into the PPC-2000 and can be selected during setup. The controller interprets or scales the electronic signals for these sensor types in engineering units (°F or °C). Other sensor types may require user-supplied scaling information. See *Setting up User Selectable Linear Inputs on page 98*.

In some cases the feedback signal may come from a value other than a sensor input. Using a Soft Input, a logic program can determine the feedback to a channel.

Control Algorithm

The PPC-2000 determines the appropriate output signal when a set point is supplied and the controller is set to automatically control a loop. The controller calculates the output based on the feedback and the control algorithm. Each channel may use either On/Off or any combination of Proportional, Integral and Derivative (PID) control modes. See *Control Algorithms on page 220* for information on these control modes.

The PPC-2000 also includes a manual reset term that may be used in conjunction with some of the PID modes. See *Channels on page 115* for more information on these parameters.

Control Output Signal Forms

The output level calculated by the controller is represented by a percent (0-100%) of power to be applied. That value is applied on a digital or analog output according to the user-selected output type. See *Output Control Forms on page 224* for more information on the output types available.

Heat and Cool Outputs

The 48 control channels may each have one or two outputs. Often a heater is controlled according to the feedback from a thermocouple and, in that case, only one output is needed.

In other applications, it is possible that two outputs may be used for control according to one input. If, for example, a system with a heater and proportional valve that controls cooling water flow are controlled according feedback from one thermocouple, the channel has one input and two outputs.

In such systems, provisions are made in the control algorithm to avoid switching too frequently back and forth between the heat and cool outputs. The On/Off algorithm uses the Spread parameter to prevent this bucking. See *Channels on page 115* for more information. When PID control is used for one or both channel outputs, both the spread and the PID parameters determine when control switches between heating and cooling.

The PPC-2000 provides two methods for coordinating a heat and a cool output driven by a single channel. The **Control Type** parameter offers two choices PID1 and PID2. *Table 3.1* describes these two algorithms.

Table 3.1 Control Types PID1 and PID2

PID1	Only the heat output or the cool output is on at any instant in time. The spread parameter provides a minimum switching hysteresis between the two outputs. The channel will not switch from heating to cooling until the heat integral sum has dropped to zero, which is to say until the process variable has been above set point for some amount of time. When the spread is set to zero, however, the channel switches from heat to cool depending on the PID calculation only, regardless of whether the process variable is above the set point.
PID2	When a channel uses the PID2 control type, the cool output will come on whenever the process variable is above the set point by more than the spread setting. The cool output remains on until the process variable drops to the set point. The heat output operates as it would if the cool output were not enabled. This algorithm was developed for plastic extruders, but may be of benefit whenever a load is typically heated but occasionally needs cooling.

Setting up Control Channels

Closed-loop control channels can be set up in various ways in the PPC-2000. The following procedure identifies the basic steps:

1. See *Inputs on page 127* for descriptions of the input parameters. On the **Inputs** spreadsheet:
   a. Choose the appropriate **Input Type** for the sensor connected to each analog input you have wired.
   b. Choose **Units** for each analog input.
   c. For any linear voltage, current, or pulse sensors, set the linear scaling parameters (**Input Signal Lo, Input Signal Hi, PV Lo,** and **PV Hi**). See *Setting up User Selectable Linear Inputs on page 98*.
2. See *Channels on page 115* for descriptions of the channel parameters. On the **Channels** spreadsheet:
   a. Choose the input in the **PV Source** field that you want to monitor or use as feedback for closed-loop control for each channel.
   b. Choose outputs in the **Heat Output Dest** and/or **Cool Output Dest** fields for each channel that you want to use for closed-loop control.
   c. Choose a **Heat/Cool Output Type** for each output.
   d. Set the **Heat/Cool Cycle Time** for any outputs with **Heat/Cool Output Type** set to **Time Prop**.
3. See *Digital I/O on page 132* for descriptions of the digital I/O parameters. On the **Digital I/O** spreadsheet:
   a. Set the **Direction** for each I/O point to be used for control to **Output**.
4. On the **Channels** spreadsheet:
   a. Set the **Heat/Cool Prop Band** for any outputs with **Heat/Cool Output Type** set to **On/Off** to 1.
   b. Set the PID parameters (**Heat/Cool Prop Band**, **Heat/Cool Derivative**, and **Heat/Cool Integral**) for each output used for PID control. The parameters may be determined by performing an autotune on each channel or by other means. See *Autotuning on page 93* or more information on autotuning.
   c. If both heat and cool outputs are used, set the **Spread**.
   d. Set the **Set Point** to the desired value and the **Control Mode** to **Auto** to begin closed-loop control.

Autotuning

Autotuning is a process by which a controller determines the correct PID parameters for optimum control.

Prerequisites

Before autotuning the controller, it must be installed with control and sensor circuitry and the thermal load in place. It must be safe to operate the thermal system, and the approximate desired operating temperature (set point) must be known.

The technician or engineer performing the autotune should know how to use HMI software interface (e.g. *AnaWin3*) to perform the following:

- Set a channel's set point
- Change a channel's control mode (manual, tune, auto)
- Read and change the controller's parameters

Background

Autotuning is performed at the maximum allowed output. If you have set a limit, autotuning occurs at that value. Otherwise, the control output is set to 100% during the autotune. Only the heat output of a channel may be autotuned.

The PID constants are calculated according to process's response to the output. The channel need not reach or cross set point to successfully determine the PID parameters. While autotuning the controller looks at the delay between when power is applied and when the system responds in order to determine the integral term (**Heat/Cool Integral**). The controller also looks for the slope of the rising temperature to become constant in order to determine the proportional band (**Heat/Cool Prop Band**). The derivative term (**Heat/Cool Derivative**) is derived mathematically from the integral term.

When the controller has finished autotuning, the channel's control mode switches to Auto. If the process reaches 80% of the set point or the autotuning time exceeds ten minutes, the controller switches to Auto and applies the PID constants it has calculated up to that point. If the tune can not get good data, the controller returns to its previous control state (i.e., manual mode) and leaves the PID parameters unchanged.

The Watlow Anafaze autotune is started at ambient temperature or at a temperature above ambient. However, the temperature must be *stable* and there must be sufficient time for the controller to determine the new PID parameters.

Tuning Method

The steps to autotune a channel are:

1. In manual control set the set point to the value you will use for the autotune.
2. Note the value of the input filter.
3. Set the input filter to 0 scans.
4. Set the control mode to tune.
5. Wait for the channel to autotune.
6. Restore the input filter to its original value.
7. Note the PID parameters for future reference.

NOTE! ***A channel must be stable at a temperature well below the set point in order to successfully autotune. The controller will not complete tuning if the temperature exceeds 75% of set point before the new parameters are found.***

Using *AnaWin3* to Tune

The following procedure explains how to autotune a channel using *AnaWin3*.

1. Choose *AnaWin3's* **Channels** spreadsheet screen and locate the channel to be tuned.
2. Ensure that the temperature is stable, and the channel is in manual control mode (typically 0% heat output level).
3. Note which input is used as the **PV Source** for the channel.
4. On the **Inputs** spreadsheet, note the setting of the **Input Filter** for that input, and then set it to 0 scans.
5. On the **Channels** spreadsheet, increase the Set Point to a value such that the temperature will not rise from 60% to 80% of that value in less than 10 seconds when heated at 100% output.
6. Select **Tune** as the **Control Mode**.

   When tuning is completed, the control mode changes to **Auto**.
7. Adjust the Set Point to the desired temperature.
8. Restore the setting of the input filter to its original value.

CAUTION! ***Never set the set point above the safe operating limits of your system.***

Alarms

The controller has three different kinds of alarms: failed sensor alarms, the global alarm, and process alarms. For information on each of these alarms, refer to the following sections.

Failed Sensor Alarms

Failed sensor alarms indicate T/C breaks and failed RTDs due to open leads.

When a channel is in **Auto** or **Tune** mode and a failed sensor alarm occurs, the controller sets the channel to **Manual** control at the **Sensor Fail Heat%** or **Sensor Fail Cool%** set in the **Channels** spreadsheet.

A failed sensor alarm is only detected for an input that is selected as the **PV Source** for a channel.

Global Alarm

The global alarm occurs when a channel alarm set to **Alarm** (not **Control**) occurs or when there are any failed sensor alarms. If an alarm occurs, the **!Alarm** screen displays the corresponding alarm message. The global alarm output stays on until the original alarm is acknowledged.

Process Alarms

Process alarms include high and low deviation and high and low process alarms. Each of these alarms may be enabled or disabled. If enabled, each may be set to function as an alarm or a control. Refer to *Alarms on page 123* for descriptions of the parameters used to set up these alarms. *Table 3.2* describes the difference between Alarm type and Control type alarms.

Table 3.2 Alarm Types

Alarm Type	Description
Alarm	Standard alarm function. Digital output, or Soft Bool, if selected, activates on alarm, deactivates when channel is not in alarm. Global alarm output activates and requires alarm acknowledgment to clear.
Control	Digital output, or Soft Bool, if set, activates on alarm, deactivates when channel is not in alarm. Global alarm output does not activate. No alarm acknowledgment required to clear.

High and low process and deviation alarms activate when the process variable goes outside the limits set by the user. The alarm remains active until both the process variable comes within the limit and the deadband, and the alarm is acknowledged.

Any digital output not used as a control output can be assigned to a process alarm. The output activates when the alarm is active. Set the **Logic** of outputs used with alarms to determine whether the alarm output turns on or off when an alarm occurs.

An alarm output remains active only as long as the process variable remains outside the alarm limit and deadband. Once the process variable is within the limit and deadband, the output reverts to the inactive state. No alarm acknowledgment is required.

When the controller powers up or the set point changes, deviation alarms set to alarm type do not activate until the process variable comes within the deviation alarm band, preventing deviation alarms during a cold start. Deviation alarms set to control type activate whenever the process variable is outside the deviation band.

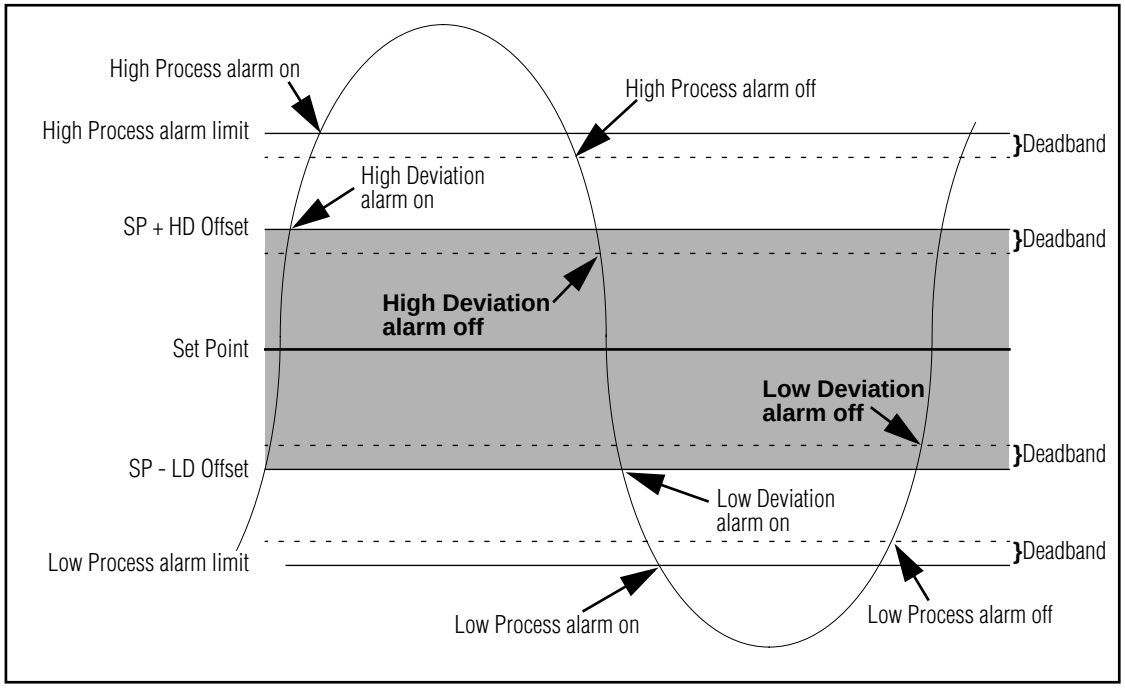


Figure 3.2 Process Variable Alarms

Alarm Delay

The controller may be configured to delay alarm reporting. **Alarm Delay** delays failed sensor alarms and process alarms for the channel. Only alarms that are continuously present for longer than the alarm delay time are reported.

Setting up Process and Deviation Alarms

To enable alarms on the process variable for a channel follow these steps. See *Alarms on page 123* for descriptions of the alarm parameters.

On the **Alarms** spreadsheet:

1. Set the **Alarm Deadband**.
2. Set the **Alarm Delay**.
3. For each alarm you wish to activate:
    a. Set the alarm limits in the corresponding fields: **LP Limit, LD Offset, HD Offset, HP Limit**.
    b. Choose the alarm behavior by setting the corresponding field (**LP Type, LD Type, HD Type, HP Type**) to **Alarm** or **Control**.
    c. Choose an available digital output to activate when the alarm occurs, if desired, in the corresponding field (**LP Output Dest, LD Output Dest, HD Output Dest, HP Output Dest**).
4. On the **Dig I/O** spreadsheet, set the **Logic** of each output used for alarms as desired.
5. Return to the **Alarms** spreadsheet. Enable the alarm by setting the corresponding field (**LP Enable, LD Enable, HD Enable, HP Enable**) to **Enabled**.

Setting up User Selectable Linear Inputs

The **Input Type** and linear scaling fields (**Input Signal Lo, Input Signal Hi, PV Lo** and **PV Hi**) appear on the **Inputs** spreadsheet. Linear input types are used with sensors whose signals are straight line (linear) functions of the quantity being measured. For example, a sensor that supplies a voltage signal proportional to the pressure it detects would use one of the linear input types and the signal would be converted to a process variable using the scaling values set on the **Inputs** spreadsheet. To define the conversion function, the user specifies two points on the line. See *Figure 3.3*.

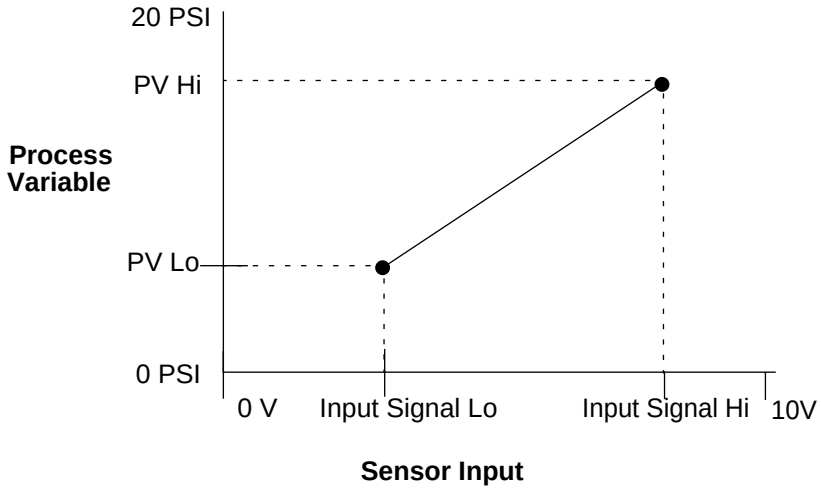


Figure 3.3 Linear Input Example

Choosing a Linear Input Type

To set up a linear input first choose an **Input Type**. There are seven user selectable linear input types: three input types for voltage signals, one for current, two for frequencies, and one for counts. Pick an **Input Type** with the appropriate signal type (voltage, current, frequency or counts). Also choose an **Input Type** with the appropriate range and sensitivity for the sensor. Generally, the appropriate **Input Type** for **Soft Inputs** is Linear (Counts).

Table 3.3 Range and Sensitivity of the Custom Linear Input Types

Input Type	Range	Input Resolution	Update Rate
Linear -1 to 10 (V)	-1.000 to 10.000V	.0003V	*
Linear -0.1 to 1 (V)	-100.0 to 1000.0mV	.03mV	*
Linear -10 to 100 (mV)	-10.00 to 100.0mV	.003mV	*
Linear -2 to 20 (mA)	-2.000 to 20.000mA	.0006mA	*
Linear (Counts)	-32768 to 32767 Counts	1 count	4Hz
Linear 0 to 300.00 (Hz)	-327.68 to 327.67Hz	.04Hz	.04Hz
Linear 0 to 10k (Hz)	-32768 to 32767Hz	4Hz	4Hz

** Depends on module type. See Chapter 7, Specifications.*

Setting Input Signal Lo and Input Signal Hi

After choosing the **Input Type**, set the **Input Signal Lo** and **Input Signal Hi**. The **Input Signal Lo** is the lowest level signal the sensor will supply. Typically this corresponds to the lowest process variable to be measured. The **Input Signal Hi** is the highest level signal the sensor will supply. Typically this corresponds to the highest process variable to be measured.

Setting Engineering Units

Set the engineering units in which you will specify the **PV Lo** and **PV Hi**. When used with linear inputs, the **Units** parameter is for display only and has no effect on the process variable value calculated or displayed.

Setting PV Lo and PV Hi

After setting the **Input Signal Lo** and **Input Signal Hi**, set the corresponding **PV Lo** and **PV Hi**. The **PV Lo** is the process variable measured when the sensor signal is at the level set in the **Input Signal Lo** field. The **PV Hi** is the process variable measured when

the sensor signal is at the level set in the **Input Signal Hi** field. Both parameters are entered in units for the input.

Setting Decimal Places

Set the **Decimal Places** parameter to determine how many decimal places are entered and displayed in the **Process Variable**, **Set Point** and alarm limits (**LP Limit**, **LD Offset**, **HD Offset**, **HP Limit**) for channels with the corresponding input selected as the **PV Source**. The range for **Decimal Places** is limited by the range of the PV to be displayed. The more decimal places to be displayed, the smaller the range of PV that can be displayed; therefore, the greater the difference between the **PV Lo** and **PV Hi**, the fewer the decimal places that can be displayed.

Table 3.4 shows the maximum range for the PV for each **Decimal Places** setting. For example, a sensor that measures pressure over a range of 0-1000 Torr set up with a **PV Hi** equal to 1000 Torr would limit the choices of **Decimal Places** to 0 or 1. Two decimal places would not be possible when the PV must go up to 1000 because when two decimal places are used the highest PV that can be displayed is 327.67.

AnaWin3 automatically sets the **Decimal Places** to the maximum allowable setting when the **PV Lo** or **PV Hi** is changed.

Table 3.4 PV Range permitted for various Decimal Places Settings

Decimal Places	PV Lo minimum	PV Hi maximum
0	-32768	32767
1	-3276.8	3276.7
2	-327.68	327.67
3	-32.768	32.767
4	-3.2768	3.2767

Linear 0-10Vdc Input Example

For a sensor that measures pressures from 0.0 to 15.0 psia and outputs a 0-10Vdc signal, set the following parameters:

Table 3.5 Scaling Parameters for 0-10Vdc Linear Input Example

Parameter	Setting	Units
Input Type	Linear -1 to 10 (v)	
Units	psia	
Input Signal Lo	0.000	V
Input Signal Hi	10.000	V
PV Lo	0.0	psia
PV Hi	15.0	psia
Decimal Places	1	

Linear 4-20mA Input Example

For a sensor that measures relative humidity with a range of 0.00 to 100.00% and outputs a 4-20mA signal, set the parameters according to *Table 3.6*.

Table 3.6 Scaling Parameters for 4-20mA Linear Input Example

Parameter	Setting	Units
Input Type	Linear -2 to 20 (mA)	
Units	%	
Input Signal Lo	4.000	mA
Input Signal Hi	20.000	mA
PV Lo	0.00	%
PV Hi	100.00	%
Decimal Places	2	

Linear 0-1Vdc Input Example

For a sensor that measures light intensity between 0 and 500 Lumens and outputs a 0-1Vdc signal, set the following parameters:

Table 3.7 Scaling Parameters for 0-1Vdc Linear Input Example

Parameter	Setting	Units
Input Type	Linear -0.1 to 1 (v)	
Units	Lumens	
Input Signal Lo	0.0	mV
Input Signal Hi	1000.0	mV
PV Lo	0	Lumens
PV Hi	500.0	Lumens
Decimal Places	1	

Process Variable Retransmit

This feature allows you to output signals representing the process variables of *source* channels or other analog inputs on the heat and cool outputs of a *retransmit* channel. The analog input selected as the **PV Source** of the retransmit channel is output on the heat output. The analog input selected as the **Set Point Source** of the retransmit channel is output on the cool output.

The output signals are scaled using the **Min Set Point** and **Max Set Point** and **Heat/Cool Scale Hi** and **Heat/Cool Scale Lo** parameters. *Figure 3.4* illustrates how the output signals are related to the analog inputs by these scaling parameters.

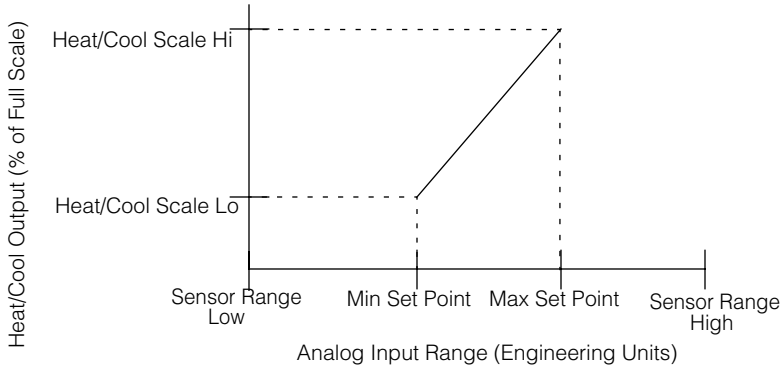


Figure 3.4 Linear Scaling of the Analog Input for Retransmit on the Heat or Cool Output

A channel cannot be used for closed-loop control when it is configured as a retransmit channel.

Setting up Process Variable Retransmit

On the Channels spreadsheet for the channel that will output the retransmit signal:

1. Set the **Control Type** to **PV Retransmit.**
2. Set the **PV Source** to the same setting as the **PV Source** parameter of the channel to be retransmitted or any other analog input you want to retransmit.
3. Set the **Heat Output Dest** to the PPC output on which you want to retransmit the analog input.
4. Set the **Heat Output Type** to a setting appropriate for the heat output destination you chose in step 3.
5. Set the **Min Set Point** to the minimum value of the analog input that you want to retransmit.
6. Set the **Max Set Point** to the maximum value of the analog input that you want to retransmit.

To retransmit a second analog input on the same retransmit channel with the same scaling:

1. Set the **Set Point Source** to the second analog input to be retransmitted.
2. Set the **Cool Output Dest** to the ~~PPC~~ analog output on which you want to retransmit
3. Set the **Cool Output Type** to a setting appropriate for the cool output destination you chose in step 2.

If you do not wish to use the full range of the heat or cool output type signal, the signal can be scaled:

1. Set the **Heat Scale Lo** to a percent of the range of the selected heat output type. This is the signal level that will be transmitted when the analog input selected as **PV Source** is at the value you entered for **Min Set Point**.
2. Set the **Heat Scale Hi** to a percent of the range of the selected heat output type. This is the signal level that will be transmitted when the analog input selected as **PV Source** is at the value you entered for **Max Set Point**.
3. Set the **Cool Scale Lo** to a percent of the range of the selected cool output type. This is the signal level that will be transmitted when the analog input selected as **Set Point Source** is at a value you entered for **Min Set Point**.

4. Set the **Cool Scale Hi** to a percent of the range of the selected cool output type. This is the signal level that will be transmitted when the analog input selected as **Set Point Source** is at the value you entered for **Max Set Point.**

5. Set the Control Mode for the channel to Auto.

Process Variable Retransmit Example

In this example, channel 1 on the PPC measures a furnace temperature with a thermocouple connected to an Analog Input module and controls the firing of a power controller with an output from the Processor module. The PPC is equipped with an Analog Out module configured for current outputs. Channel 2 is used to retransmit channel 1's process variable from one of these analog outputs to a chart recorder. The chart recorder requires a 4-20mA dc signal. This signal range represents 0 to 1000°F on the chart. *Figure 3.5* illustrates this example. *Table 3.8* lists the settings used on the retransmit channel.

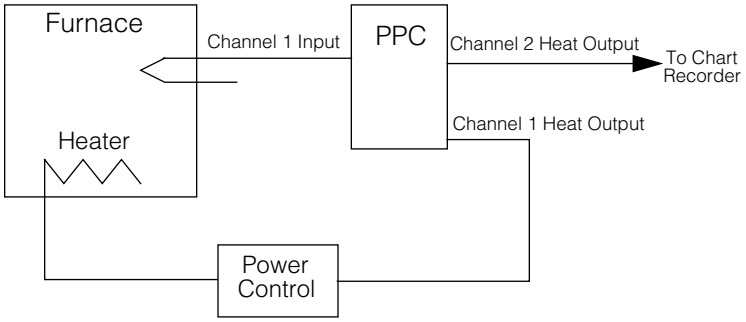


Figure 3.5 Sample Application Using Process Variable Retransmit

Table 3.8 Retransmit Channel Parameter Settings

Parameter	Setting	Description
Control Type	PV Retransmit	This disables normal closed-loop control and enables the PV retransmit feature.
Heat Output Dest	PPC1:AO 31.1	The first output on the Analog Output module with its address set to 31 will be used to retransmit channel 1's process variable.
PV Source	PPC1:AI 1.1	The analog input to be retransmitted is from the first sensor on the Analog Input module with its address set to 1.
Heat Output Type	Analog 4-20mA	A 4-20mA signal is output representing the value of the analog input.
Min Set Point	0°F	When the analog input value is less than or equal to 0°F, channel 2's output will be 4mA.
Max Set Point	1000°F	When the analog input value is equal to or greater than 1000°F, channel 2's output will be 20mA.
Control Mode	Auto	

Cascade Control

Cascade control is used with thermal systems with long lag times, which cannot be as accurately controlled with a single control loop. To accomplish this, the output of the *primary* channel is used to adjust the set point of the *secondary* channel. The secondary channel executes the actual control.

In some applications, two zone cascade control systems are used. In such systems, the primary channel's output is used for heat control and the secondary channel's output is used for a heat boost. Such arrangements are used in metal applications such aluminum casting. The PPC's cascade control feature allows the primary channel's output to be used both to determine the secondary channel's set point and as an actual control output.

The secondary channel's set point is determined according to the heat and cool output values from the primary loop and the user supplied **Max Set Point** and **Min Set Point** parameters. *Figure 3.6* and *Figure 3.7 on page 106* illustrate the relationship between the primary channel's output and the set point of the secondary channel.

When the primary channel has both heat and cool outputs enabled, the secondary channel's set point is equal to the **Min Set Point** setting when the cool output is at 100%. (See *Figure 3.6*) When the primary loop has only its heat output enabled, the secondary channel's set point is equal to the **Min Set Point** setting when the heat output is at 0%. (See *Figure 3.7 on page 106)* In either case, the secondary channel's set point is equal to the **Max Set Point** setting when the heat output is at 100%.

For a cool only primary channel, the secondary channel's set point is equal to the **Min Set Point** when the primary channel's cool output is at 100% and equal to the **Max Set Point** when the primary channel's cool output is at 0%.

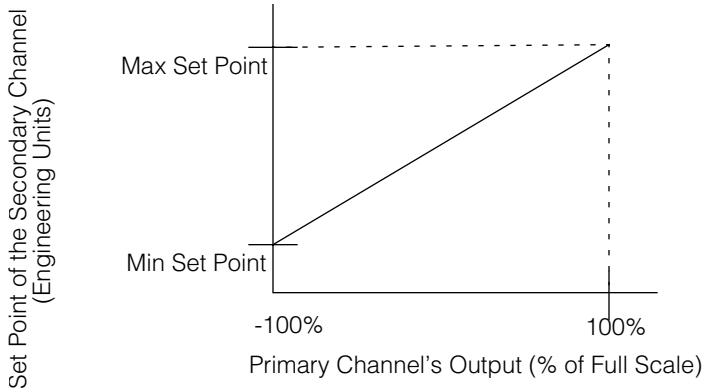


Figure 3.6 How the Secondary Channel's Set Point is Determined When the Primary Channel Has Heat and Cool Outputs

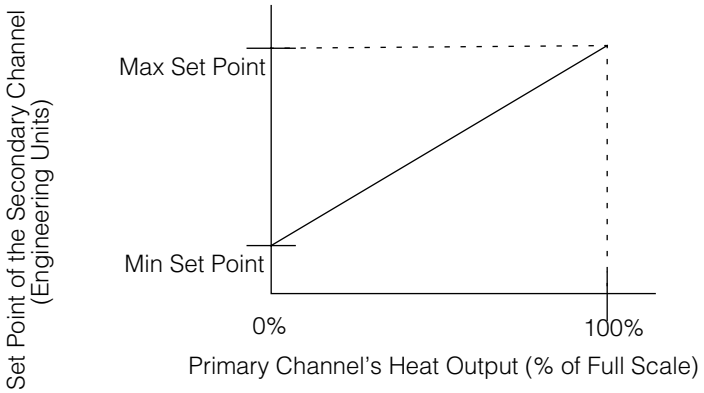


Figure 3.7 How the Secondary Channel's Set Point is Determined When the Primary Channel Has Only a Heat Output

Setting up Cascade Control

To setup cascade control:

1. Set up the primary loop. See *Cascade Control Example below*.
2. Set up control for the secondary loop as you would for a standard closed-loop application. See *Setting up Control Channels on page 92*.
3. On the secondary channel:
   a. Select the primary channel's output (**Channel # Out**) for the **Set Point Source** setting.
   b. Set the **Min Set Point** to the desired set point when the primary channel's output is at its minimum value.
   c. Set the **Max Set Point** to the desired set point when the primary channel's output is at its maximum value.

Cascade Control Example

The temperature of a tank of water is controlled by a heater near the bottom of the tank. Two thermocouples measure the water temperature. One is placed near the heater and is referred to as the inner TC. The other is placed in the center of the tank and referred to as the outer TC. The desired temperature of the water at the outer TC is 150°F.

The outer TC is connected to the first input on the Analog Input module. Output 22 on the Processor module is used to drive a solid state relay power control. *Figure 3.8 on page 107* illustrates this application.

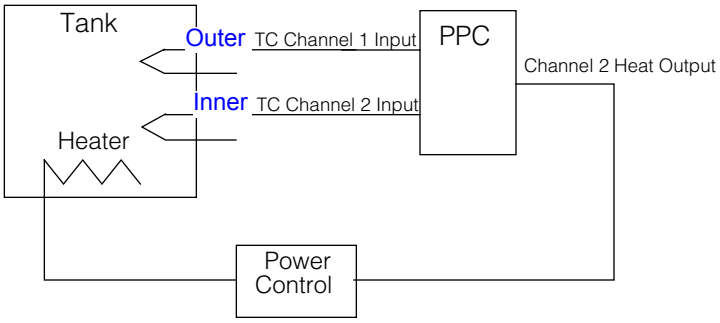


Figure 3.8 Sample Application Using Cascade Control

For cascade control the outer TC is selected as the **PV Source** for the primary channel, and the inner TC is selected as the **PV Source** for the secondary channel. The secondary channel's output is used to control the heater.

An engineer familiar with the process has determined that as the temperature of the outer (primary) TC drops from 150°F to 140°F, the set point of the secondary channel should rise from 150°F to 190°F. *Table 3.9* and *Table 3.10 on page 108* list the parameter settings for the primary and secondary channels.

The PID parameters of the primary channel must be tuned to produce the desired effect on the secondary channel's set point. The primary channel typically uses *proportional only* control. Disabling the integral and derivative components of PID makes the secondary set point a predictable function of the primary channel's process variable.

The proportional band is selected so the set point of the secondary channel has the desired relationship to the process variable of the primary channel. In this application, the proportional band of the primary channel is set to 10°F.

Table 3.9 Primary Channel Parameter Settings

Parameter	Setting	Description
PV Source	PPC1:AI 1.1	The outer TC is selected for the primary channel.
Set Point	150°F	The desired temperature at the inner TC.
Heat Prop Band	10	As the input drops 10°F, the output increases to 100%.
Heat Integral	0	Only proportional control is used.
Heat Derivative	0	Only proportional control is used.
Heat Output Dest	PPC1:Soft Bool	The primary output must be enabled, but is not used to drive a load.

Table 3.10 Secondary Channel Parameter Settings

Parameter	Setting	Description
PV Source	PPC1:AI 1.2	The inner TC is selected for the secondary channel.
Set Point Source	Channel 1 Out	For cascade control, the primary channel's output determines the secondary channel's set point.
Min Set Point	150°F	When the primary channel's output is 0% the secondary channel's set point is 150°F.
Max Set Point	190°F	When the primary channel's output is 100% the secondary channel's set point is 190°F.
Heat Prop Band	The secondary channel's PID parameter values may be determined by autotuning or manual tuning.	
Heat Integral		
Heat Derivative		

As the temperature in the middle of the tank (channel 1) drops, the output goes up proportionally and the set point of channel 2 goes up proportionally. Thus heat is added to the system at the element even though the temperature near the element may have been at the desired temperature.

With proportional control, when channel 1 is at set point, its output is 0%, and the set point of channel 2 is equal to the desired temperature 150°F. If the temperature of the channel 1 drops below 149°F, the deviation results in a proportional output of 10%. This results in an increase to the set point for channel 2 equal to 10% of the set point range. The set point range is defined by **Max Set Point** - **Min Set Point**. In this case the range is 40°F (190°F - 150°F = 40°F). Ten percent of 40°F is 4°F. So when the temperature at channel 2 drops 1 degree, channel 2's set point increases by 4°F to 154°F. For every degree channel 1 drops, channel 2's set point increases by 4°F until channel 1's output is 100% and channel 2's set point is 190°F. At this point further decreases to channel 1's process variable have no additional affect on channel 2. *Figure 3.9 on page 109* illustrates this relationship.

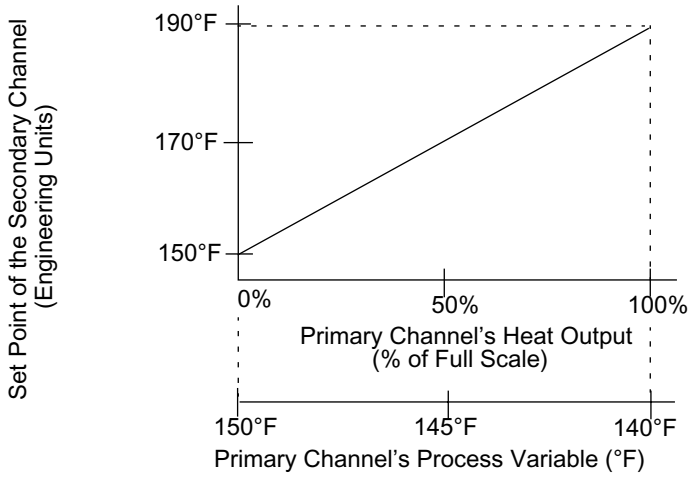


Figure 3.9 The Secondary Channel's Set Point is Determined by the Primary Channel's Process Variable

Ratio Control

Using ratio control the process variable of one channel or any analog input can determine the set point of another channel. With ratio control the set point of the *ratio* channel is calculated by multiplying the process variable value of the *master* channel by a ratio then adding an offset.

Set Point Ratio and **Set Point Offset** are user set parameters. By adjusting these parameters, you can adjust the relationship between the process variable of the master channel and the set point of the ratio channel. *Figure 3.10 on page 110* illustrates this relationship.

The set point of the ratio loop is limited by the settings of **Max Set Point** and **Min Set Point.**

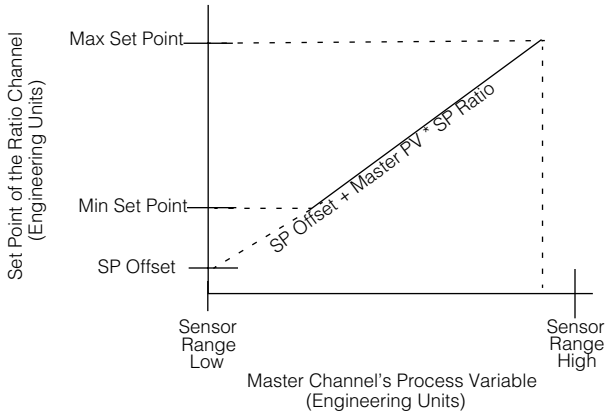

Max Set Point
Min Set Point
SP Offset
SP Offset + Master PV * SP Ratio
Set Point of the Ratio Channel (Engineering Units)
Sensor Range Low
Sensor Range High
Master Channel's Process Variable (Engineering Units)

Figure 3.10 Relationship between the Master Channel's Process Variable and the Ratio Channel's Set Point.

Setting up Ratio Control

To set up ratio control:

1. Set up the master channel as you would for a standard closed-loop application. See *Setting up Control Channels on page 92*.
2. Set up the ratio channel as you would for a standard closed-loop application.
3. Make the following additional settings on the ratio channel:

    a. For **Set Point Source** select the analog input that should be used to determine the set point (the **PV Source** of the master channel).

    b. Set the **Set Point Ratio** and **Set Point Offset** to create the desired relationship between the analog input's value and the ratio channel's set point.

    c. Set the **Min Set Point** to the lowest set point value the ratio channel should ever have.

    d. Set the **Max Set Point** to the highest set point value the ratio channel should ever have.

Ratio Control Example

A chemical process requires a formula of two parts water to one part Potassium Hydroxide (KOH) to produce diluted Potassium Hydroxide. The desired flow of water is 10 gallons per second (gps) and the KOH should flow at 5 gps. Separate feeder pipes for each chemical feed in to a common pipe. The flow rate of each feeder pipe is measured by flow transducers providing 0-5Vdc signals to analog inputs on a PPC. Motorized valves controlling the flow of each chemical are controlled by outputs from the PPC. *Figure 3.11* illustrates this application.

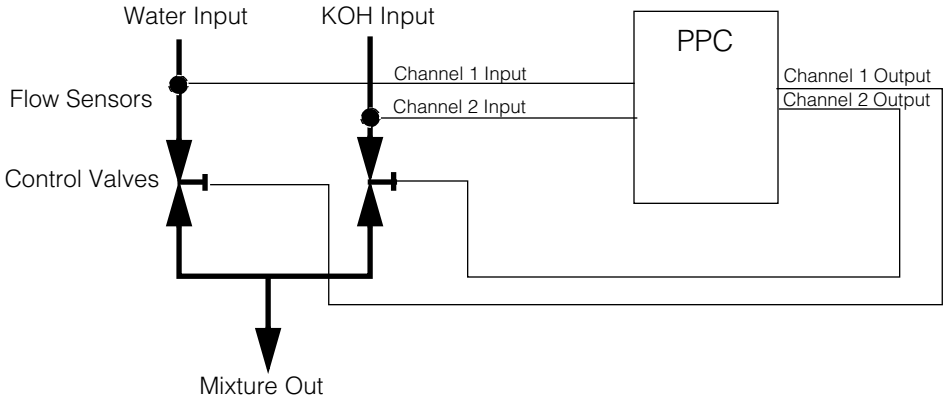


Figure 3.11 Sample Application Using Ratio Control

In this application the first input on an Analog Input module is set up to convert the linear voltage signals from the flow sensors to gallons per second (gps). The water flow is controlled by channel 1. The KOH flow is controlled by channel 2 and is set up as the ratio channel. The KOH flow set point must be half of the water flow value.

The process engineer doesn't want the KOH set point to exceed 15 gps regardless of the water flow. *Table 3.11* lists the channel parameter settings for the ratio KOH channel.

Table 3.11 Ratio Channel Parameter Settings

Parameter	Setting	Description
Set Point Source	PPC1:AI 1.1	The **PV Source** of the master channel.
Set Point Ratio	0.5	KOH should flow at one half of the water flow rate.
Set Point Offset	0 gps	When water flow is 0 gps the KOH flow should be 0 gps.
Min Set Point	0 gps	When the water flow is 0 gps the KOH flow should be 0 gps.
Max Set Point	15 gps	The KOH set point will not exceed 15 gps.

Differential Control

Differential control is a special case of ratio control. With differential control, as with ratio, the set point of one channel is determined by the process variable value of another channel. The set point of the differential channel is calculated by adding an offset (**Set Point Offset**) to the process variable value of the master channel. The **Set Point Ratio** parameter is set to 1.

Remote Set Point

Remote set point is implemented in the PPC as a special case of ratio control. As with ratio control, the set point of a channel is set by multiplying an analog input value by a ratio (**Set Point Ratio**) and adding an offset (**Set Point Offset**). Typically, however, the analog input is not used as feedback for closed-loop control, so there is no master channel. The **Max Set Point** and **Min Set Point** parameters may be used to limit the set point value. Setup remote set point according to the instructions for ratio control.

Logic Programs

The PPC-2000 is able to run not only the closed-loop control program but also a user-written logic program. *LogicPro* is a software program that runs under Windows95/98/NT. This logic programming tool can be used to customize the function of the PPC-2000 controller. Any of the digital and analog I/O as well as all of the controller parameters can be accessed and changed by user written logic programs. Logic programs are stored along with the controller firmware in nonvolatile memory. Consult the *LogicPro User's Guide* for specific instructions on how to write, compile and download logic programs to the PPC-2000.

NOTE! ***If an output variable in a logic program sets a value using an IO Driver and IO Physical Address, the associated register in the PPC-2000 cannot be written to by the closed-loop control program, an HMI or any other device.***

Setting up Analog Inputs for Use with a Logic Program

The closed-loop control program updates any analog input whether it is selected as the source for a channel or not. A logic program can read and use the scaled Input Value from the PPC's datatable.

Set up the input as you would for a closed-loop control channel. Select an **Input Type**, set the **Units**, and set scaling parameters if using a Linear Input type. See *Setting up User Selectable Linear Inputs on page 98*.

Setting up Outputs for Use with a Logic Program

Various types of conditioned outputs are available for logic programs. These outputs include digital outputs conditioned for time proportioning, DZC, SDAC and analog outputs scaled in units of 0.0 to 100.0%. Conditioned outputs are not accessed directly from the I/O physical address but rather through channels' output address. See *Accessing Channel Parameters with LogicPro on page 173.* In order to have the logic program write to these outputs, a loop must be set up with the output destination, output type, and PV source. An unused input may be used for the PV source. The loop should be in **Manual** mode. The logic program can then write to the **Heat** or **Cool Output%**, and the **Heat** or **Cool Output Type** will determine the kind of conditioning performed.

Using Logic to Set an Analog Input

A logic program can set a process variable by outputting a value to one of the **Soft Input** registers. The **Soft Inputs** show up on the Inputs Spreadsheet and the list of options for **PV Source** in AnaWin. To use the logic calculated value, select the **Soft Input** as the **PV Source** and set up the channel as usual.

Starting and Stopping Logic Programs

After developing and downloading a logic program with *LogicPro*, use the PPC Globals screen in *AnaWin3* to start and stop the logic program.

To start the logic program:

1. Select the **View** menu.
2. Select **PPC Globals**.
3. Double-click on the **Start Logic Program** button.
4. Click on the **Send** button to command the PPC to start the logic program
   -or-
   click **Cancel**.

CAUTION! ***The logic program will begin executing immediately after clicking the Send button. Assure that the equipment is in a safe condition to run logic.***

To stop the logic program:

1. Select the **View** menu.
2. Select **PPC Globals**.
3. Double-click on the **Stop Logic Program** button.
4. Click the **Send** button to command the PPC to stop the logic program
   -or-
   click **Cancel**.

CAUTION! ***When stopping the logic program, all PPC digital outputs are turned off. Outputs controlled by a closed-loop control channel or a process alarm resume outputs on the next scan. Ensure the logic program can be safely stopped. If necessary, shutdown logic should be integrated into the logic program.***

To set whether the logic program runs on power up or not:

1. Select the **View** menu.
2. Select **PPC Globals**.
3. Double-click the **Logic Start State** button.
4. Select **Startup Running** or **Startup Not Running**.
5. Click the **Send** button.

CAUTION! ***When the logic start state is set to Startup Running, the logic program begins executing immediately on power up. Ensure the equipment is in a safe condition to run logic.***

CAUTION! ***Closed-loop control is disabled during logic downloads. Control modes are set to Off. Ensure that all loops can be safely disabled before downloading programs. After the program has been successfully downloaded, loops remain in the Off mode.***

Controller Parameters

View and set the parameters that determine how the PPC interprets inputs, performs closed-loop control, operates outputs, and monitors process variables for alarm conditions on *AnaWin3's* **Spreadsheet Overview** screen. Select the buttons on the **PPC** tab to configure the seven spreadsheets (**Channels**, **Alarms**, **Inputs**, **Dig I/O**, **Outputs**, **Soft INT**, and **Soft BOOL**), each detailed below.

Global parameters are found on the **PPC Globals** screen under *AnaWin3's* **View** menu.

These parameters may also be accessed by a properly configured operator interface terminal or third-party software. Parameter definitions and ranges are defined below. When using a third-party interface, refer to *Chapter 5, Custom Interfacing,* for additional information.

Channels

Select the **Channels** button to configure or monitor PPC channel parameters. Channel names are located in the first column; each channel has a row of parameters associated with it. These parameters control the behavior of the closed-loop control channels and determine which sensor input and control outputs are used.

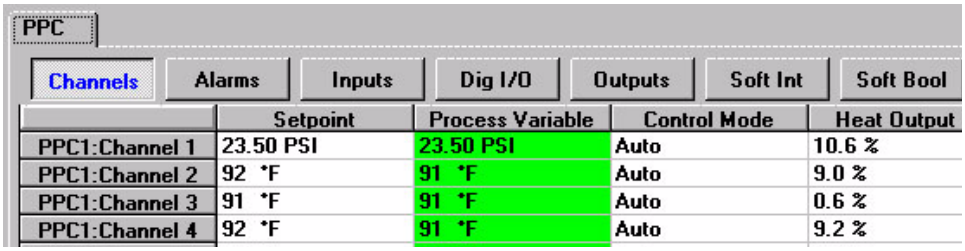


Figure 3.12 Channels Spreadsheet

Channel names indicate the controller and the channel. For example, **PPC1:Channel 3** indicates the third channel on the first PPC.

Each channel can have one input and one or two outputs (heat and/or cool). Many of the channel parameters may be individually set for the heat and cool outputs. For example, **Heat Prop Band** is the proportional band for the heat output and **Cool Prop Band** is the proportional band for the cool output.

A description for each parameter in **Channels** follows.

Set Point

The set point is the desired value for the process variable. Use this field to enter a set point for the selected channel. If the set point entered is out of the defined range, the controller assigns the closest number within the range.

Range: same as the range of the input type selected. See *Table 3.14 on page 130*.

Process Variable

This field shows the actual value measured by the sensor attached to the input selected in the **PV Source** field for the channel. The process variable is used in the channel's feedback calculation. This field is read-only.

Range: same as the range of the input type selected. See *Table 3.14 on page 130*.

Control Mode

This parameter indicates the mode of control:

- **Off —** Select this option to turn off closed-loop control. Any associated output will not be set by the closed-loop control program and cannot be set manually or by a logic program.
- **Manual —** Output is set by the user or a logic program. See **Heat Output%** and **Cool Output%** earlier in this section.
- **Auto —** Output is determined by the PID or on/off control algorithm.
- **Tune —** The loop determines and sets its proportional band, derivative and integral parameters by setting the output and measuring the system's response. See *Autotuning on page 93*.

Heat Output%

Enter a heat output value in percent when the channel is in manual control mode, or monitor the output in automatic control. For PID output types, the output is calculated based on the heat PID parameters.

Range: **0.0%** to **100.0%**

Cool Output%

Enter a cool output value in percent when the channel is in manual control mode, or monitor the output in automatic control. For PID output types, the output is calculated based on the cool PID parameters.

Range: **0.0%** to **100.0%**

PV Source

Select the input used as the process variable for this channel. Choose one of the displayed analog inputs. Use the scroll bar in the pop-up window to view the available inputs.

Range: **Not Assigned** and all the analog inputs on the **Inputs** spreadsheet.

Set Point Source

Select a setting to determine how the set point for the channel is set. Select **User** for normal closed-loop control applications. Select a channel output (**Channel # Out**) for cascade control. Select an analog input for ratio control, differential control, remote set point, or process variable retransmit.

Range: **User, Channel 1 Output** to **Channel 48 Output**, and all analog inputs on the **Inputs** spreadsheet.

Min Set Point

Enter the minimum value the PPC should accept for the set point of the channel. This parameter is also used to scale a cascade channel. *(*See *Cascade Control on page 105).*

Range: The range is the same as that of the input type for the channel.

Max Set Point

Enter the maximum value the PPC should accept for the set point of the channel. This parameter is also used to scale a cascade channel. (See *Cascade Control on page 105).*

Range: The range is the same as that of the input type for the channel.

Set Point Ratio

For ratio control, differential control, and remote set point applications, set the ratio by which the analog input value selected as the **Set Point Source** is multiplied to calculate the set point. (See *Ratio Control on page 109*, *Differential Control on page 112,* and *Remote Set Point on page 112*.)

Range **0.01** to **300.0**

Set Point Offset

For ratio control, differential control, and remote set point applications set the offset which is added to the product of the analog input value selected as the **Set Point Source** and the **Set Point Ratio** to calculate the set point. (*Ratio Control on page 109, Differential Control on page 112,* and *Remote Set Point on page 112*.)

Range: -32768 to 32767 (Decimal placement depends on the **Input Type** selected.) See *Table 3.15 on page 130*.

Control Type

Select the function of the channel. Refer to *Table 3.12*. Refer to *Heat and Cool Outputs on page 90* for more on PID1 and PID2.

Table 3.12 AnaWin3 Control Types

Control Type	Description
PID1	Heat and Cool outputs used to control. Only one output may be on at a time.
PID2	Heat and Cool outputs used to control. Both outputs can be on at the same time.
Retransmit	Choose this type to use the channel to retransmit one or two analog inputs.

Heat/Cool Prop Band

Set the proportional band. Larger numbers result in less proportional action for a given error or deviation from set point. This parameter is set in engineering units.

Range: depends on the input type. See *Table 3.15 on page 130*.

Heat/Cool Integral

Enter the integral term value which controls the amount of influence the history of error has on the output. Increasing the integral value decreases the integral contribution to the output. Entering an integral value of 0, however, yields no integral action. This value is in seconds per repeat.

Range: **0** to **6000** seconds/repeat

Heat/Cool Derivative

Enter the derivative term value which controls the amount of influence the rate of change of the error has on the output. A greater value yields a greater derivative action. The derivative constant is in units of seconds.

Range: **0** to **255** seconds

Heat/Cool Man Reset

Enter a value to add to the PID output calculation. When the corresponding Integral is set to zero, the value substitutes for the integral sum portion of the feedback calculation. In this case, the output equals the heat/cool manual reset value when the process variable is at set point. When the integral value is set to a value other than zero, the manual reset value is added to the result of the PID calculation and, thereby, shifts the output variable.

Range: **0.0%** to **100.0%**

Heat/Cool Output Dest

Select the output destination to specify the I/O point used for the control output. This is the output for the closed-loop control channel. Selecting **Not Assigned** indicates no output is to be used, and is an appropriate setting for monitor-only channels.

If both heat and cool output destinations are set, the channel performs bimodal control. See *Heat and Cool Outputs on page 90* for more information on this type of control.

Range: Any output found on the **Dig I/O** or **Outputs** spreadsheet or any of the **Soft Bool** or **Soft Int** registers.

Heat/Cool Output Type

This field specifies the type of output signal and determines whether the PID or on/off control algorithm is used for the channel. Refer to *AnaWin3 Output Types on page 120* for a description of the output type options.

Table 3.13 AnaWin3 Output Types

Output Type	Description	Function
Time Prop	digital, time proportioned	Percent output converted to a percent duty cycle over the user-selected fixed time.
DZC	digital, distributed zero crossing (not available for mechanical relay outputs)	Output on/off state calculated for every AC line cycle.
On/Off	digital, on/off	Output either full ON or full OFF
Internal Count	Integer register	Calculated output may be used by a logic program
Analog 0-20mA	Analog output type, 0-20mA	Analog output using a PPC-2030 or PPC-2050 through 2053
Analog 4-20mA	Analog output type, 4-20mA	
Analog 0-5Vdc	Analog output type, 0-5Vdc	
Analog 1-5Vdc	Analog output type, 1-5Vdc	
Analog 0-10Vdc	Analog output type, 0-10Vdc	
SDAC 0-20mA	Serial digital-to-analog converter, 0-20mA	Analog output using a digital output from the PPC-2010 module connected to a peripheral SDAC module
SDAC 4-20mA	Serial digital-to-analog converter, 4-20mA	
SDAC 0-5Vdc	Serial digital-to-analog converter, 0-5Vdc	
SDAC 1-5Vdc	Serial digital-to-analog converter, 1-5Vdc	
SDAC 0-10Vdc	Serial digital-to-analog converter, 0-10Vdc	

Heat/Cool Cycle Time

Specify the time base for time proportional outputs. The output percentage is proportioned over this time period. For example, a 50% output with a 10-second cycle time is on for 5 seconds and off for 5 seconds. **Heat/Cool Cycle Time** only affects control when the corresponding output type is set to **Time Prop** (digital time proportioning).

Range: **0** to **255** seconds

Heat/Cool Curve

Indicate which output scaling method is to be used.

- **Straight Linear —** Output is unaffected and is set as calculated by the closed-loop PID calculation.
- **Lag Curve A —** Output is reduced somewhat from calculated value.
- **Lag Curve B —** Output is further reduced from calculated value.

Straight linear is used for most applications. Lag curves are usually used in plastic extruder applications.

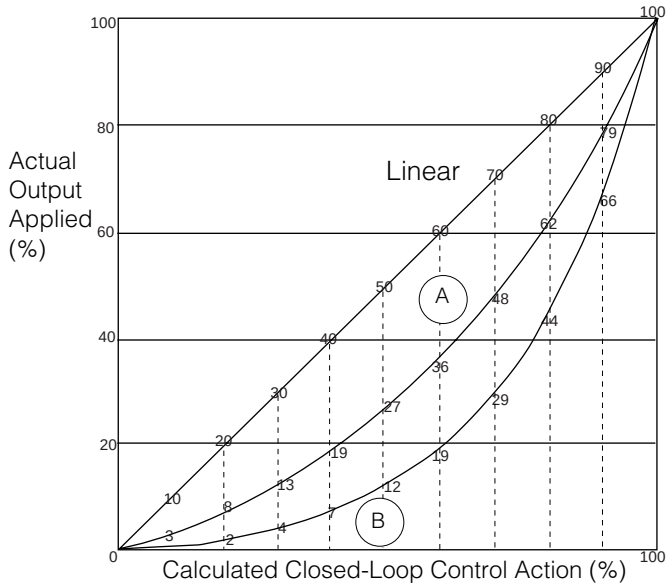


Figure 3.13 Output Scaling (Heat/Cool) Curves

With **Lag Curve A** or **Lag Curve B** selected, a PID calculation results in a lower actual output level than the linear output requires. This output is used when the response of the system to the output device is non-linear.

Heat/Cool Output Filter

Use this menu to damp the heat or cool output's response. The output responds to a step change by going to approximately 2/3 of its final value within the number of scans set here. A larger number yields a slower, or more damped, control response to changes in the calculated output.

Range: **0** to **100** scans; 0 disables the filter

Auto Heat/Cool Limit

Use this menu to limit the control output for a channel's heat and cool outputs. This limit may be continuous, or it may be in effect for a specified number of seconds (see **Heat/Cool Limit Time** below). If you choose a timed limit, the heat/cool limit restarts when the controller powers up and when the channel changes from Manual to Automatic control. The heat/cool limit only affects channels under automatic control. It does not affect channels under manual control.

Range: **0.0%** to **100.0%**

Heat/Cool Limit Time

Set a time limit for the **Auto Heat/Cool Limit**. If set to **0**, the heat/cool limit is in affect whenever the channel is in automatic control.

Range: **0** to **32767** seconds

Heat/Cool Scale Lo

A control output may be linearly scaled by setting this parameter. Enter the percent of the output range of the selected **Heat/Cool Output Type** that should correspond to a calculated **Heat/Cool Output%** of **0%**.

Range: **0.0%** to **100.0%**

Heat/Cool Scale Hi

A control output may be linearly scaled by setting this parameter. Enter the percent of the output range of the selected **Heat/Cool Output Type** that should correspond to a calculated **Heat/Cool Output%** of **100%**.

Range: **0.0%** to **100.0%**

Sensor Fail Heat% / Cool%

When a failed sensor alarm occurs on a channel under automatic control, that channel goes to manual control at the percent power output set here. Enter the default percentage to which a channel's output is set if its input sensor fails.

Range: **0.0%** to **100.0%**

Spread

Enter the offset between heat and cool modes when both heat and cool outputs for a channel are used. The spread is also the switching hysteresis for on/off channels with **Output Type** set to **On/Off**. The spread is in the channel's engineering units.

Range: same as the range of the input type selected. See *Table 3.14 on page 130*.

Heat/Cool Scale Lo
Set this parameter in conjunction with **Heat/Cool Scale Hi** to scale the output or to change the control action. (See table 3.x.) Enter the value, as a percent of range, that the output should approach as the process variable approaches the set point from below for a heat output or from above for a cool output. See Figure 3.x.

The default and typical value is 0%. For example, as a heater raises the temperature of a load towards set point, the output decreases toward 0%. In some cases it is desirable that the output never reach 0%, in that case enter a minimum value greater than 0%.

Range: **0.0** to **100.0%**

Heat/Cool Scale Hi
Set this parameter in conjunction with **Heat/Cool Scale Lo** to scale the output or to change the control action. (See table 3.x.) Enter the value, as a percent of range, that the output should approach as the process variable moves away from the set point either upward for a heat output or downward for a cool output. See Figure 3.x.

The default and typical value is 100%. For example, as the temperature of a heated system drops the controller increases its output toward 100%. In some cases it is desirable that the output never reach 100%, in that case enter a maximum value less than 100%. See also **Auto Heat/Cool Limit**.

Range: **0.0** to **100.0%**

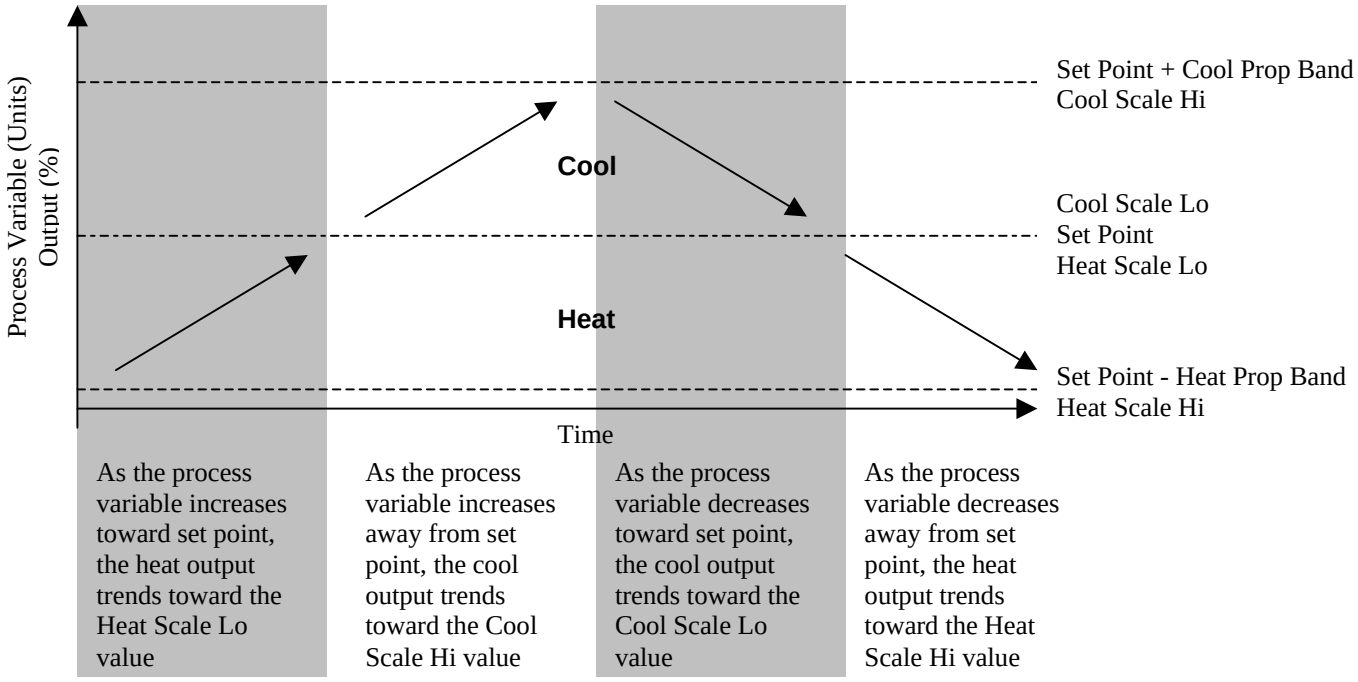
Note
Sometimes it is necessary for a heat output to *increase* as the process variable approaches the set point from below. In such cases the **Heat/Cool Scale Lo** value is set above the **Heat/Cool Scale Hi** parameter. (See Direct Heat in Table 3.x.) For example, in some systems heat is added outside the control loop and the heat output controls a cooling water flow. In such a system as the temperature rises to set point, the output increases to flow more water and slow the heating process.

Table 3.x Output Scaling Parameters Settings and Control Action

Output	Control Action	Scale Lo	Scale Hi	Note
Heat	Reverse (Default)	0%	100%	As the process variable increases, the output decreases.
Cool	Reverse	100%	0%	
Heat	Direct	100%	0%	As the process variable increases, the output increases.
Cool	Direct (Default)	0%	100%	

CAUTION
When a **Heat/Cool Scale Lo** parameter is set to a value *greater* than the corresponding **Heat/Cool Scale Hi**, the **Heat Output %** or **Cool Output %** values are inversely related to the actual output signal. In this case when the **Heat/Cool Output %** indicates 0% the output is *fully on* regardless of whether the **Control Mode** is set to Auto, Manual or Tune. Always remove power from the controller before servicing any components.

Figure 3.x Heat and Cool Scaling Parameters


Process Variable (Units)
Output (%)
Set Point + Cool Prop Band
Cool Scale Hi
Cool
Cool Scale Lo
Set Point
Heat Scale Lo
Heat
Set Point - Heat Prop Band
Heat Scale Hi
Time
As the process variable increases toward set point, the heat output trends toward the Heat Scale Lo value
As the process variable increases away from set point, the cool output trends toward the Cool Scale Hi value
As the process variable decreases toward set point, the cool output trends toward the Cool Scale Lo value
As the process variable decreases away from set point, the heat output trends toward the Heat Scale Hi value

Alarms

Parameters on the **Alarms** spreadsheet enable and set the behavior of the process and deviation alarms for each channel.

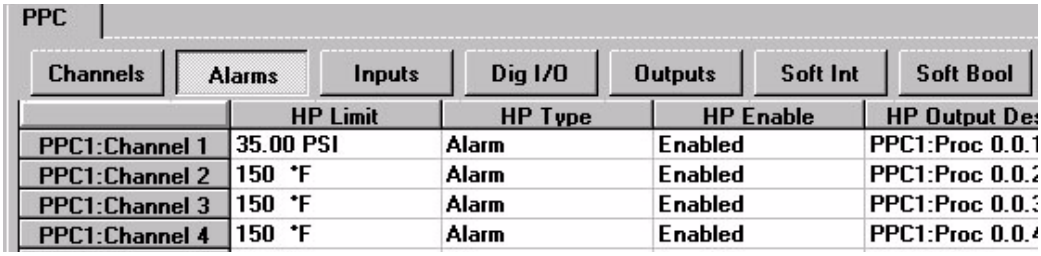


Figure 3.14 Alarms Spreadsheet

Select the **Alarms** button to configure or monitor PPC alarm parameters. Channel names are located in the first column; each channel has a row of associated alarm parameters. For example, **PPC1:Channel 3** indicates PPC #1 and channel #3.

HP Limit

Enter the value at which you want the high process alarm to activate. The high process alarm activates when the process variable (PV) goes above the high process set point. The PV must drop to the alarm set point minus the alarm deadband for the alarm to clear.The default high process alarm set point is **0**.

Range: same as the range of the input type selected. See *Table 3.15 on page 130*.

HP Type

Select the function of the high process alarm. See *Process Alarms on page 95* for a description of the settings.

Range: **Alarm** or **Control**

HP Enable

Set this field to enable or disable the high process alarm. When it is Enabled, the high process alarm activates if the process variable (PV) rises above the **HP Limit**. The PV must drop below the **HP Limit** minus the alarm deadband to be reset (cleared). When this parameter is set to **Disabled**, the high process alarm does not occur.

Range: **Enable** or **Disable**

HP Output Dest

Choose a digital output to toggle when the high process alarm occurs. This may be any available hardware output or Soft Boolean register accessible by the logic program. The default for this parameter is **Not Assigned**. Outputs that are already assigned to control output destinations will be rejected. The same output may ~~not~~ be used for multiple alarm output destinations.

Range: **Not Assigned**, or any of the digital outputs on the **DigI/O** spreadsheet, or any of the **Soft Bool** registers.

HD Offset

Designate an offset value that determines the high deviation alarm limit relative to the current set point. The high deviation alarm occurs when the process variable is greater than the channel set point plus this value. The alarm limit changes when the set point changes. The default high deviation alarm offset is **0**.

Range: same as the range of the input type selected. See *Table 3.15 on page 130*.

HD Type

Set the high deviation alarm function. See *Process Alarms on page 95* for a description of the settings.

Range: **Alarm** or **Control**

HD Enable

Set this field to enable or disable the high deviation alarm. When it is Enabled, the high deviation alarm activates if the process variable (PV) rises above the set point by more than the **HD Offset**. The PV must drop below the high deviation limit minus the alarm deadband to be reset (cleared). When this parameter is set to **Disabled**, the high deviation alarm does not occur.

Range: **Enable** or **Disable**

HD Output Dest

Choose a digital output to toggle when the high deviation alarm occurs. This may be any available hardware output or Soft Boolean register accessible by the logic program. The default for this parameter is **Not Assigned**. Outputs that are already assigned to control output destinations will be rejected. The same output may ~~not~~ be used for multiple alarm output destinations.

Range: **Not Assigned**, or any of the digital outputs on the **DigI/O** spreadsheet, or any of the **Soft Bool** registers.

LD Offset

Designate an offset value that determines the low deviation alarm limit relative to the current set point. The low deviation alarm occurs when the process variable is lower than the channel set point less this value. The alarm limit changes when the set point changes. The default low deviation alarm offset is **0**.

Range: same as the range of the input type selected. See *Table 3.15 on page 130*.

LD Type

Set the function of the low deviation alarm. See *Process Alarms on page 95* for a description of the settings.

Range: **Alarm** or **Control**

LD Enable

Set this field to enable or disable the low deviation alarm. When it is Enabled, the low deviation alarm activates if the process variable (PV) dips below set point by more than the **LD Offset**. The PV must rise above the low deviation limit plus the alarm deadband to be reset (cleared). When this parameter is set to **Disabled**, the low deviation alarm does not occur.

Range: **Enable** or **Disable**

LD Output Dest

Choose a digital output to toggle when the low deviation alarm occurs. This may be any available hardware output or Soft Boolean register accessible by the logic program. The default for this parameter is **Not Assigned**. Outputs that are already assigned to control output destinations will be rejected. The same output may ~~not~~ be used for multiple alarm output destinations.

Range: **Not Assigned**, or any of the digital outputs on the **DigI/O** spreadsheet, or any of the **Soft Bool** registers.

LP Limit

Set the low process alarm limit. An alarm occurs when the process variable is less than this value. This value does not change when the set point changes. The default low process alarm set point is **0**.

Range: same as the range of the input type selected. See *Table 3.15 on page 130*.

LP Type

Select the function of the low process alarm. See *Process Alarms on page 95* for a description of the settings.

Range: **Alarm** or **Control**

LP Enable

Set this field to enable or disable the low process alarm. When it is Enabled, the low process alarm activates if the process variable (PV) dips below the **LP Limit**. The PV must rise above the **LP Limit** plus the alarm deadband to be reset (cleared). When this parameter is set to **Disabled**, the low process alarm does not occur.

Range: **Enable** or **Disable**

LP Output Dest

Choose a digital output to toggle when the low process alarm occurs. This may be any available hardware output or Soft Boolean register accessible by the logic program. The default for this parameter is **None**. Outputs that are already assigned to control output destinations will be rejected. The same output may ~~not~~ be used for multiple alarm output destinations.

Range: **None**, or any of the digital outputs on the **DigI/O** spreadsheet, or any of the **Soft Bool** registers.

Alarm Deadband

Set this parameter to prevent process and deviation alarms from toggling on and off when the process variable is near the alarm limit set point. For high alarms the deadband is below the set point; for low alarms the deadband is above the set point. An alarm that occurs when the process variable crosses the alarm set point will not clear until the process returns within the alarm set point, and the deadband value. The default alarm deadband is **2**.

Range: Depends on the input type selected.

Alarm Delay

Set this parameter to delay alarm reporting. Use this feature to prevent false alarms due to noise on sensors. The alarm delay applies to failed sensor alarms and process and deviation alarms. Only alarms that are present for longer than alarm delay time are reported.

Range: **0** to **100** seconds

Inputs

Parameters on the **Inputs** spreadsheet determine how measurements of signals from sensors attached to the analog input modules are read and scaled into engineering units for use by closed-loop control channels, monitor channels and logic programs.

PPC

Channels | Alarms | Inputs | Dig I/O | Outputs | Soft Int | Soft Bool

	Input Value (PV)	Input Status	Input Type	
PPC1:AI 1.1	23.50 PSI	No Problem	Linear -1 to 10 (V)	PSI
PPC1:AI 1.2	91 °F	No Problem	J T/C	°F
PPC1:AI 1.3	91 °F	No Problem	J T/C	°F
PPC1:AI 1.4	91 °F	No Problem	J T/C	°F

Figure 3.15 Inputs Spreadsheet

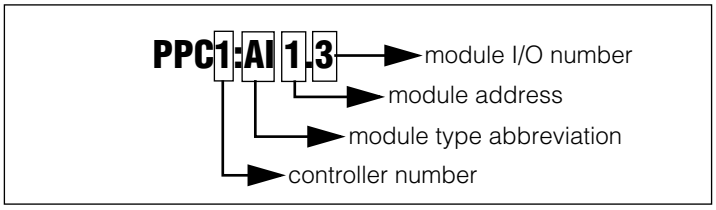


Figure 3.16 Analog Input Names

Select the **Inputs** button to configure or monitor PPC input parameters. Input names are located in the first column; each input has a row of associated parameters. The default input name identifies the PPC, module and module I/O number. Double-click on a parameter to edit it.

The module type is indicated in the default input name. Module types are abbreviated. See *Table 3.14* for a description.

Table 3.14 Module Abbreviations Seen on the Inputs Spreadsheet

Module Type	Abbreviation
PPC-202x Analog Input	AI
PPC-2030 Encoder Input Analog Output	EIAO
PPC-2010 Processor	Proc
PPC-2040 Digital I/O	DIO

For example, **PPC1:AI 1.3** indicates PPC #1, the analog input module with address 1, and input #3. For a description of module addresses, see *Module Addresses on page 17* for a table that correlates the module I/O numbers with screw terminals on the AITB, see *Table 2.13 on page 48*.

The Processor module, Digital I/O, and Encoder In Analog Output modules accept pulse inputs. Both the count and frequency of each pulse signal are listed as inputs. Pulse input names identify the PPC, module, I/O type and module I/O number and indicate counter (C) or frequency (F). See example in *Figure 3.17*.

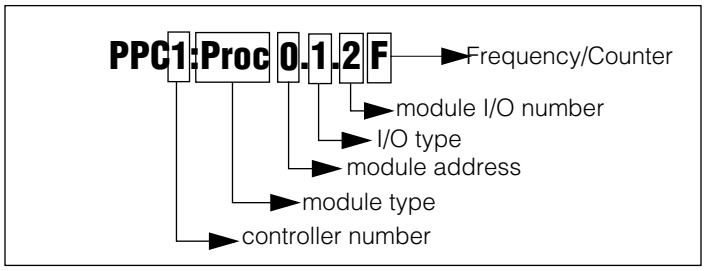


Figure 3.17 Pulse Input Names

Soft inputs appear on the Inputs spreadsheets. A soft input can be selected as the **PV Source** of a channel when that channel is to get its feedback from a logic program. There are 50 soft inputs in a PPC. These inputs are not associated with any physical I/O. A value written to a soft input by a logic program is treated as a raw input and is scaled and filtered according to its input parameter settings. If a soft input is selected as a **PV Source**, the input type will be set automatically to Linear (counts). *Figure 3.18* illustrates how soft input names appear in the spreadsheet.

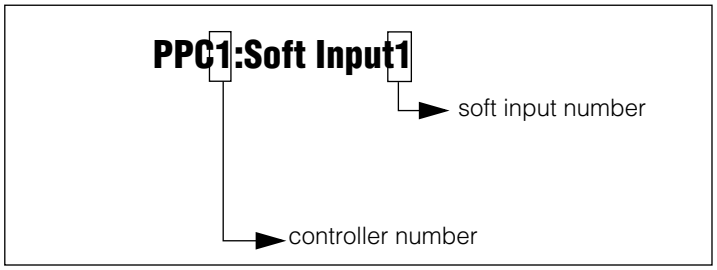


Figure 3.18 Soft Input Names

Channel outputs appear on the Inputs spreadsheets. A channel output can be selected as the **Set Point Source** of a channel for cascade control applications. (See *Cascade Control on page 105*.) There are 48 channel outputs in a PPC. These inputs get their value from the sum of the **Heat Output %** and **Cool Output %** of each channel. Channel outputs are treated as raw inputs and are scaled and filtered according to the input parameter settings. *Figure 3.19 on page 129* illustrates how channel output names appear in the spreadsheet settings.

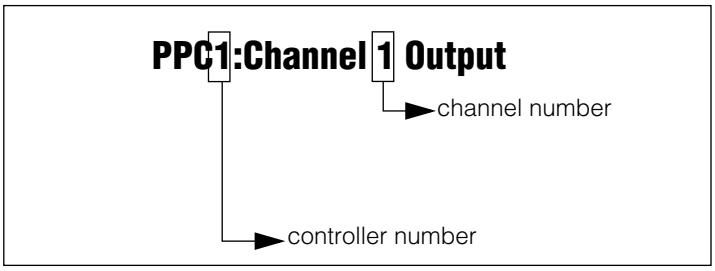


Figure 3.19 Channel Output Names

Table 2.15 on page 56 correlates module I/O numbers with screw terminals on the EITB.

Input Value (PV)

This field displays the scaled and filtered value measured by the sensor attached to the corresponding input. This field is read-only.

Range: Depends on input type selected. See *Table 3.15*.

Input Status

This field displays information about the sensor.

- **No Problem —** sensor is functioning as expected.
- **Open Sensor —** T/C or RTD not properly connected.
- **CMO —** Common Mode Overvoltage, there is too much noise on the sensor to make an accurate reading.
- **Shorted RTD sensor.**
- **Ambient temperature error —** temperature is outside controller's operating range.

If two or more problems occur simultaneously the **Input Status** lists the errors.

Input Type

Choose the input type appropriate for the sensor connected to the corresponding input. *Table 3.14* lists the choices available. Select **No Input** if no sensor is attached to the input.

Table 3.15 Input Types

Input Type	Sensor Range Low	Sensor Range High
No Input	N/A	N/A
Volts: -1 to 10V	-1Vdc	10Vdc
Volts: -0.5 to 5V	-0.5Vdc	5Vdc
Volts: -0.1 to 1V	-0.1Vdc	1Vdc
Volts: -50 to 500mV	-50mVdc	500mVdc
Volts: -10 to 100mV	-10mVdc	100mVdc
Volts: -5 to 50mV	-5mVdc	50mVdc
Linear -1 to 10 (V)	-1.000Vdc	10.000Vdc
Linear -0.1 to 1 (V)	-100.0mVdc	1000.0mVdc
Linear -10 to 100 (mV)	-10.00mVdc	100.00mVdc
Linear -2 to 20 (mA)	-2.000mA	20.000mA
Linear (Counts)	-32768 Counts	32767 Counts
Linear 0-300 (Hz)	-32768Hz	32767Hz
Linear 0 to 10K (Hz)	-327.68Hz	327.67Hz
Current, 0-20mA	0mA	20mA
Current, 4-20mA	4mA	20mA
Reserved	N/A	N/A
Counter	-32768 Counts	32767 Counts
Frequency	-10000Hz	10000Hz
B T/C	32°F	3308°F
C T/C	32°F	4200°F
D T/C	32°F	4200°F
E T/C	-454°F	1221°F
J T/C	-346°F	1598°F
J T/C without open sensor detection	-346°F	1598°F
K T/C	-454°F	2249°F
K T/C without open sensor detection	-454°F	2249°F
N T/C	-454°F	2372°F
R T/C	-58°F	3215°F
S T/C	-58°F	3215°F
T T/C	-454°F	752°F
F T/C (Platinel2)	32°F	2250°F
G T/C	32°F	4200°F
RTD 100 Ohm Plat	-418°F	521°F
RTD 100 Ohm Plat High	-418°F	1562°F
100K Ohm Thermistor	-25°F	327°F

NOTE! ***The counter and frequency inputs update four times per second (4Hz), except the Linear 0-300 (Hz) input type, which updates once every 25 seconds (.04Hz). The update rate of all other input types depends on the module. See Chapter 7, Specifications.***

Units

For temperature sensors, choose the temperature scale for the input value. For custom linear and pulse type inputs, choose a three-character description of the input's engineering units.

Table 3.16 Units

Input	Character Sets for Units
T/C and RTD	°F or °C
Linear or Pulse	0 to 9, A to Z,%, /, degrees, space

Decimal Places

Set the **Decimal Places** parameter to determine how many decimal places are entered and displayed in the **Process Variable**, **Set Point** and alarm limits for channels with the corresponding input selected as the **PV Source**. The range for **Decimal Places** is limited by the range of the PV to be displayed. The more decimal places to be displayed, the smaller the range of PV that can be displayed. The greater the difference between the **PV Lo** and **PV Hi** the fewer the decimal places that can be displayed.

Input Filter

Set the filter value to damp changes to the process variable. The process variable used to calculate the outputs responds to a step change by going to approximately 2/3 of its final value, within the number of scans set here. A larger number yields a slower, or more damped, response to changes as measured by the sensor.

Range: **0** to **255** scans. **0** disables the filter.

PV Offset

Enter a number to adjust the reading of an **Input Value**. For T/Cs and RTDs, the value entered here is added to the temperature measurement. For counter inputs, the value set here is loaded as the **Input Value** when it is entered. Enter **0** to reset a counter.

Range: -32768 to 32767 (Decimal placement depends on **Input Type** selected).

Input Signal Lo

For linear inputs (see *Setting up User Selectable Linear Inputs on page 98*), enter the sensor signal level that corresponds to the low process value entered in **PV Lo** (see below). The **input Signal Lo** is entered in the units of the **Input Type**.

Range: Depends on **Input Type** selected. See *Table 3.15 on page 130*.

Input Signal Hi

For linear inputs (see *Setting up User Selectable Linear Inputs on page 98*), enter the sensor signal level that corresponds to the high process value entered in **PV Hi** (see below). The **Input Signal Hi** is entered in the units of the **Input Type** selected.

Range: Depends on **Input Type** selected. See *Table 3.15 on page 130*.

PV Lo

For linear inputs (see *Setting up User Selectable Linear Inputs on page 98*), enter a low process value. Set this parameter to the value to be displayed when the signal is at the level set in **Input Signal Lo** (see above). The **Input Value (PV)** will not indicate a value less than the **PV Lo** regardless of how low the sensor signal dives. The set point and alarm limits for an associated channel cannot be set to values less than **PV Lo**.

Range: Depends on **Decimal Places.** See *Table 3.4 on page 100*.

PV Hi

For linear inputs (see *Setting up User Selectable Linear Inputs on page 98*), enter a high process value. Set this parameter to the value to be displayed when the signal is at the level set in **Input Signal Hi** (see above). The **Input Value (PV)** will not indicate a value greater than the **PV Hi** regardless of how low the sensor signal rises. The set point and alarm limits for an associated channel cannot be set to values higher than **PV Hi**.

Range: Depends on **Decimal Places.** See *Table 3.4 on page 100*.

Digital I/O

Parameters on the **Dig I/O** spreadsheet determine the state and behavior of digital or discrete inputs and outputs found on the PPC's processor and digital I/O modules.

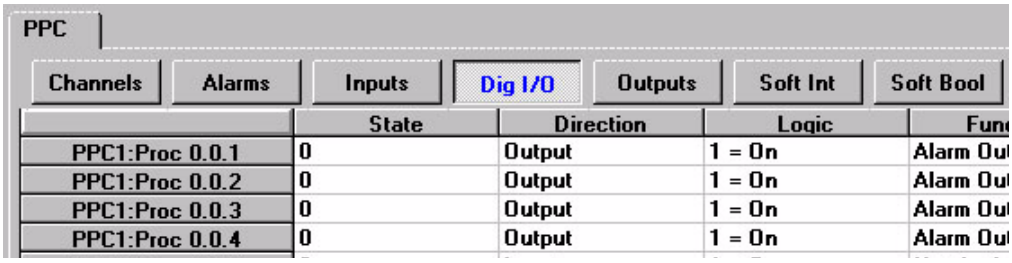


Figure 3.20 Dig I/O Spreadsheet

Select the **Dig I/O** button to configure or monitor PPC Digital I/O parameters.

I/O names are located in the first column. The I/O names identify each I/O point. Names for Processor (PPC-2010) and Digital I/O (PPC-204X) modules differ slightly from Digital Out (PPC-206X) and Digital In (PPC-207X) names. Processor and Digital I/O names include an I/O type designator because those modules support digital, count, and frequency types. For example, a Processor I/O name, **PPC1:Proc 0.0.2** indicates PPC #1, digital I/O on the processor module (which has module address 0), I/O type (0=digital) and point #2. See *Figure 3.21* for a breakdown of this example. Alternatively, the Digital Out I/O name, **PPC1:DO 41.2** indicates PPC #1, Digital Out module with address 41, and point #2. See *Figure 3.22* for a breakdown of the example. See *Table 3.17 on page 134* for module type abbreviations.

See *Table 2.10 on page 39* for a list of module I/O numbers corresponding to the TB50 terminals.

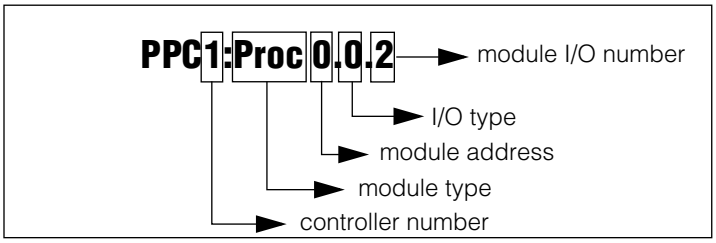


Figure 3.21 PPC-2010 and PPC-204X Digital I/O Names

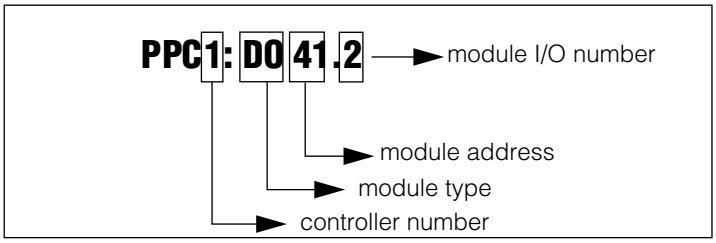


Figure 3.22 PPC-206X and PPC-207X Digital I/O Names

Table 3.17 Module Abbreviations Seen on the Digital I/O Spreadsheet

Module Type	Abbreviation
PPC-2010 Processor	Proc
PPC-204x Digital I/O	DIO
PPC-206x Digital Out	DO
PPC-207x Digital In	DI

State

This field indicates the state of the digital I/O in the system. I/O points configured as inputs are read-only.

Range: **0** or **1**

NOTE! ***The state must be interpreted in terms of the Logic setting in order to know if the I/O point is on or off. For example, if the state of an I/O point is 1 and the Logic is 1=On, then the I/O point is On (low).***

Direction

Select whether the flexible I/O points are being used as inputs or outputs. All flexible I/O points default to inputs.

Range: **Input** or **Output**

Logic

Specify the active, true level (**ON** state) for each digital I/O.

Range: **1 = On** or **0 = On**

Function

Indicates how an I/O point is being used in the system.

Table 3.18 Function Values

Not Assigned	Output not used for control or alarm
Control Output	Output selected in **Heat/Cool Output Dest** field on the **Channels** spreadsheet.
Alarm Output	Selected in **LP, LD, HD** or **HP Output Dest** field on the **Alarms** spreadsheet.

Outputs

The **Outputs** spreadsheet lists the output value for each of the analog outputs. Output behavior is set by the parameters of the channel with the output set as the output destination on the **Channels** spreadsheet.

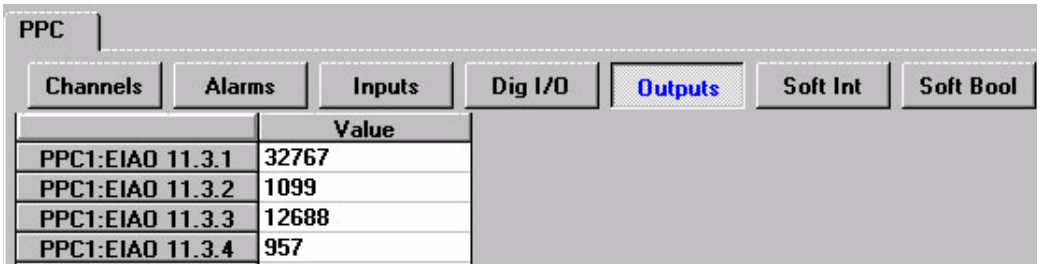


Figure 3.23 Outputs Spreadsheet

Select the **Outputs** button to monitor the analog output values.

Analog Output names are located in the first column. The Analog Output names identify the module, I/O type (if necessary), and module I/O number. The module type is abbreviated in the default I/O name. For example, **PPC1:EIAO 11.3.2** indicates PPC #1, the encoder input analog output module with module address 11, I/O type (3 = analog out), and output #2. See *Figure 3.24* and *Table 3.19*.

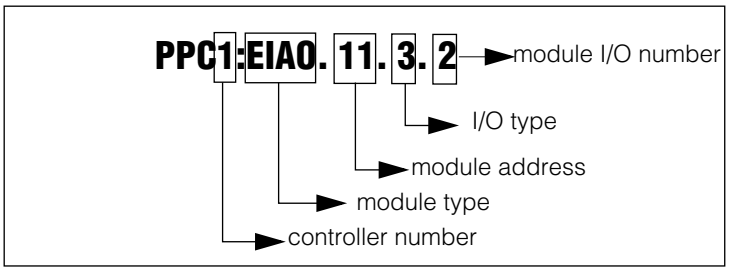


Figure 3.24 Analog Output Names

Table 3.19 Module Abbreviations Seen on the Outputs Spreadsheet

Module Type	Abbreviation
PPC-2030 Encoder Input Analog Output	EIAO
PPC-205x Analog Output	AO

There is only one parameter on the **Outputs** spreadsheet: **Value**.

Value

This parameter displays the output value of the analog output as a number between 0 and 32767. These numbers correspond to the minimum and maximum output signal levels for the selected **Output Type**. The analog signal range is determined by the hardware, jumper configuration, and the setting of the **Output Type** on the **Channels** spreadsheet for the channel with the output selected as **Heat/Cool Output Dest**. The range may also be scaled by the **Output Scale Lo** and **Output Scale Hi** settings

Range: **0** to **32767**

NOTE! ***The resolution of the analog outputs is 12 bits. The output Value is displayed as a 15-bit integer. The output Value must change by more than seven to effect a measurable change in an analog output.***

Soft Integer

The **Soft Int** spreadsheet lists the values of each of the 2100 software integer registers set aside in the PPC database for exchanging data with the logic program.

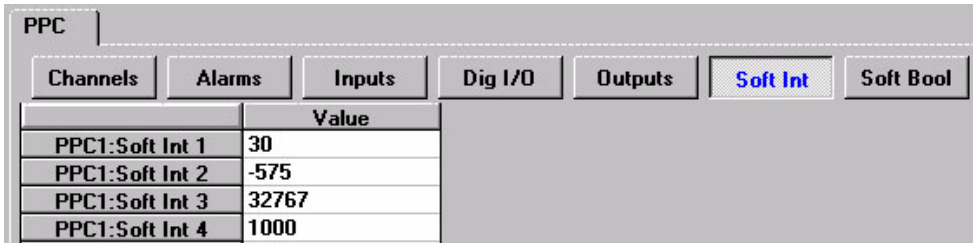


Figure 3.25 Soft Int Spreadsheet

Select the **Soft Int** button to monitor or edit the software integer values. Double click a field to change the setting.

The left column in the spreadsheet lists the name of the register. The name contains the PPC number, the word and the register offset (1-2100).

There is only one parameter on the **Soft Int** spreadsheet: **Value**.

Value

Software integer registers can be used to set or monitor values in logic program variables that have been linked to the corresponding database locations. The registers are all read/write, but if a register is set as an output in the logic program, the logic program updates its value and user entered values are disregarded.

Range: **-32768** to **32767**

Soft Boolean

The **Soft Bool** spreadsheet lists the values of each of the 1000 software Boolean registers set aside in the PPC database for exchanging data with the logic program.

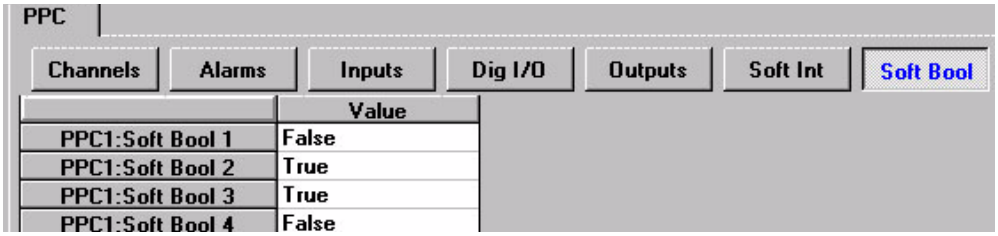


Figure 3.26 Soft BOOL Spreadsheet

Select the **Soft Bool** button to monitor or edit the software Boolean values. Double click a field to change the setting.

The left column in the spreadsheet lists the name of the register. The name contains the PPC number, the word and the register offset (1-1000).

There is only one parameter on the **Soft Bool** spreadsheet: **Value**.

Value

Software Boolean registers can be used to set or monitor internal coils in logic program that have been linked to the corresponding register. The registers are all read/write, but if a register is set as an output in the logic program, the logic program updates its value and user entered values are disregarded.

Range: **False (0)** or **True (1)**

PPC Globals

Select **PPC Globals** from the **View** menu to display the screen in *Figure 3.27*.

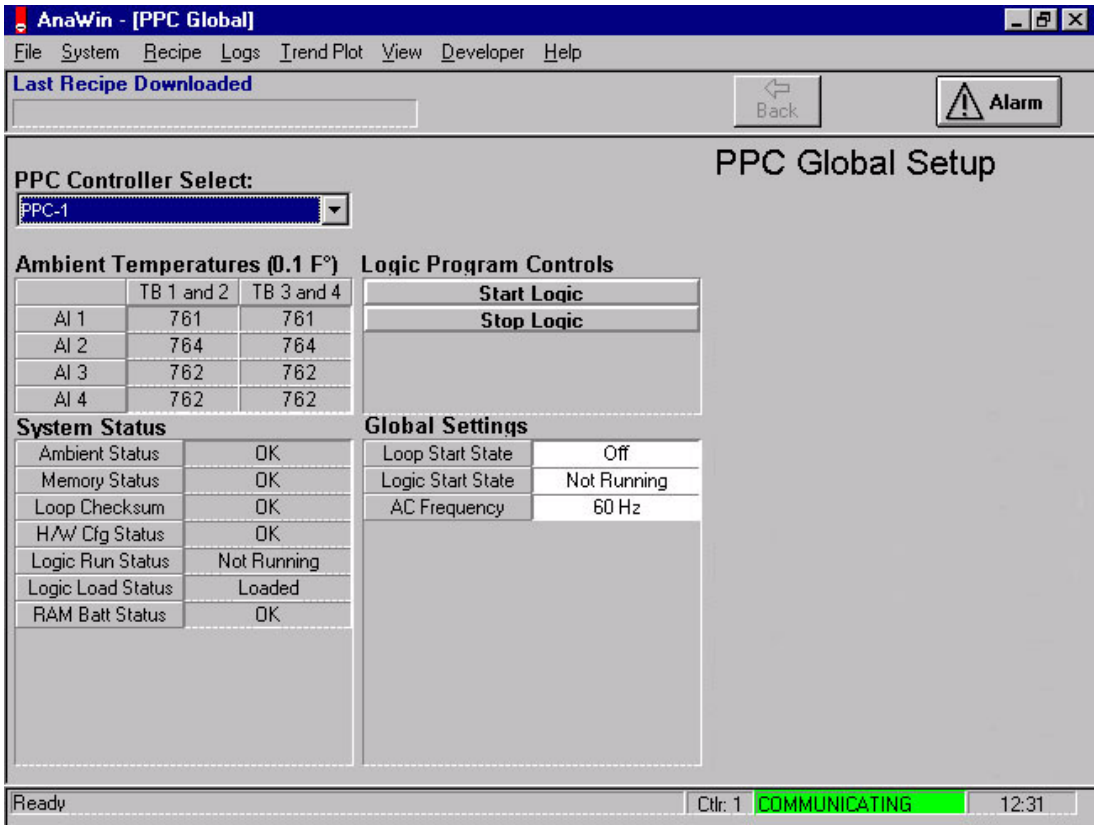


Figure 3.27 PPC Globals Screen

PPC Controller Select

Select the pertinent controller to display its parameters on this screen.

Ambient Temperatures

The analog input modules measure the temperatures of each terminal block on up to four AITBs in tenths of degrees F. These give the cold junction compensation temperature for each half of the terminal block. Note that the channel numbers associated with a given cold junction reference depend on whether the card is single-ended or differential. *Table 2.13 on page 48* correlates the terminals with the input number.

System Status

Refer to *Table 3.20* for a description of the system status parameters.

Table 3.20 System Status

Parameter	Definition
Ambient Status	Ambient temperature error
Memory Status	RAM verification error
Loop Checksum	Closed-loop control program verified
HW Cfg Status	Hardware configuration error
Logic Run Status	Logic program is/is not running
Logic Load Status	Logic program is/is not loaded
Battery Status	Battery status

Logic Program Controls

Select **Start** or **Stop** to control the logic program.

Global Settings

Refer to *Table 3.21* for a description of the global settings.

Time and Date

The PPC-2000's clock calendar automatically updates the year, month, date, hour, minute and second.

Table 3.21 Global Settings

Parameter	Definition
Loop Start State	Determines whether closed-loop control channels are set to Off mode when the PPC is powered up or reset, or whether the control channels resume operation in the same control mode that was active before the PPC was powered down.
Logic Start State	Determines whether or not the logic program, if present, runs when the PPC is powered up or reset
AC Frequency	Determines the input scan duration and DZC output time base. Set this parameter equal to the AC line frequency.

Time and Date

The PPC-2000's clock calendar automatically updates the year, day of the week, month, date, hour, minute and second.

Program Version

The Program Version is an embedded program version label for the firmware program. This selection is read-only. View the program version by selecting **About** from the **Help** menu.

4

Troubleshooting

This chapter describes troubleshooting methods and fault indicators that may be useful if you experience difficulties with your PPC-2000 system. Appropriate remedial procedures are detailed below.

General Description

The following LEDs light for status or diagnostic purposes:

- **Green:** Function operational, communications status (tx)
- **Red:** Fault
- **Yellow:** Communication status (rx)
- **Orange:** Processor reset due to low power condition or watchdog timeout

PPC-2010 Processor

The processor provides a System OK circuit for monitoring program and microcontroller integrity. The output of the watchdog timer is available through the 50 pin I/O header on the processor board. This is an open collector type output (up to 100mA) and will sink current to common when the processor is operating properly. An open circuit indicates a processor failure and remains open until proper operation is established.

Firmware Installation Procedures

Changing the firmware on the processor module involves minor mechanical disassembly and reassembly of the controller. Appropriate precautions should be taken to prevent electrostatic discharge damage to the electronic components. Wear a grounding strap and place components on static-free grounded surfaces only.

A small flathead screwdriver is needed.

All control parameters will revert to factory defaults when installing a new flash memory chip containing controller firmware. Take a "snapshot" of the current configurations using AnaWin3 before removing the flash memory chip.

The flash memory chip also stores the logic program if one has been programmed. After replacing a flash memory chip, the logic program should be downloaded to the controller using LogicPro.

CAUTION! ***Be sure to take antistatic precautions.***

1. Save snapshot. The logic program will be erased.
2. Power down the controller and system, including heaters etc.
3. Remove the power connection to the processor module and any cables between the modules and terminal boards.
4. Note and label cable locations.
5. Remove the PPC-2000 system from the DIN rail or panel.
6. Make sure the red top and bottom module latches on the processor module are in the unlocked position (pushed toward the back of the module.)

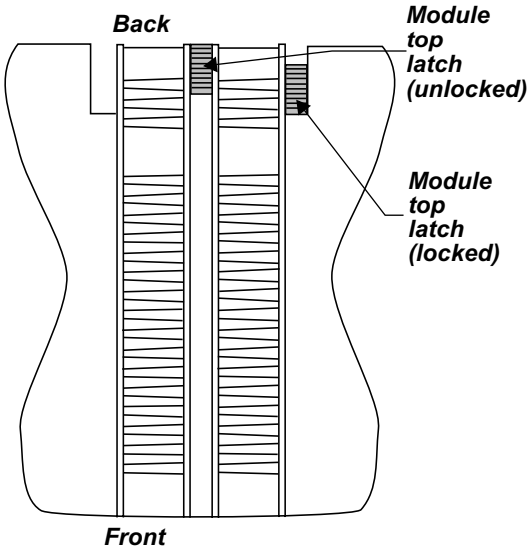


Figure 4.1 Assembled Modules Top View

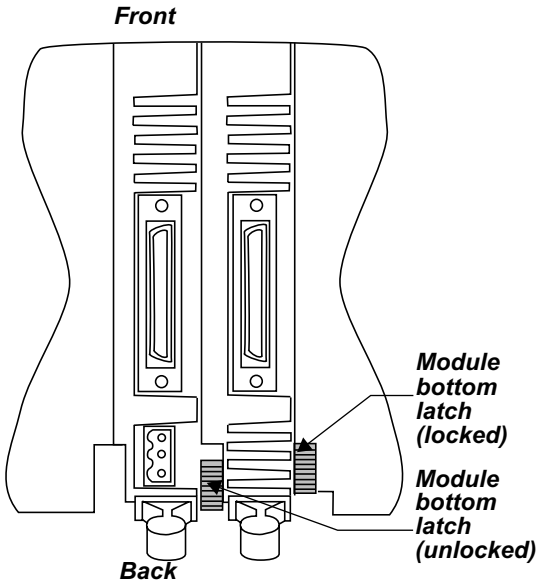


Figure 4.2 Assembled Modules Bottom View

7. Gently rock and pull the modules apart.
8. Refer to *Figure 4.3 on page 144* to locate the flash memory chip on the controller board. Use a PLCC extractor tool or insert a small flat blade screwdriver into one of the notches at the corner of the socket and gently pry the flash memory chip out of the socket.

9. Insert the new flash memory chip into the socket as shown in *Figure 4.3*, with the beveled edge and notched corner of the flash memory chip facing the bottom edge of the module. Be careful not to bend any legs while installing.
10. Reassemble the controller.
11. When the module is properly seated, close the two module latches by pushing the latches toward the front of the module. The two modules should be properly locked.
12. Replace the module on the DIN rail latch or screw the unit back to the panel.
13. Reconnect cables.
14. Power the unit.
15. Download the Snapshot from *AnaWin3* and reload the logic program from *LogicPro*, if necessary.

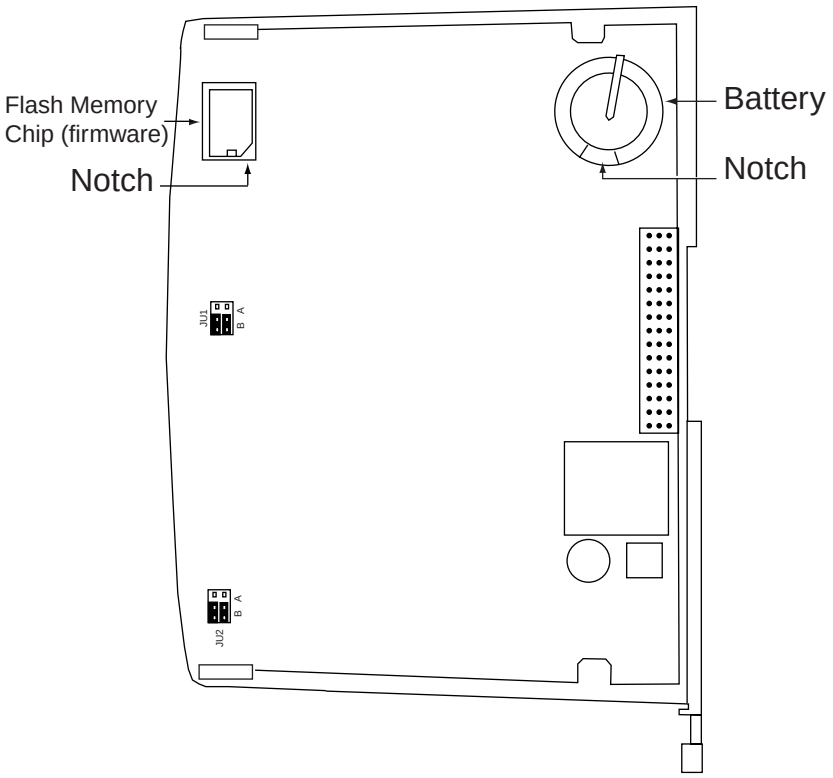


Figure 4.3 PPC-2010 Internal View

Battery Installation Procedures

Changing the battery on the processor module involves minor mechanical disassembly and reassembly of the controller. Appropriate precautions should be taken to prevent electrostatic discharge damage to the electronic components. Wear a grounding strap and place components on static-free grounded surfaces only.

A small flathead screwdriver is needed.

CAUTION! ***All control parameters and retained values in the logic program will be lost when the battery is removed! Take a Snapshot of the current configurations in AnaWin3 before removing the battery.***

Be sure to take antistatic precautions.

1. Power down the controller.
2. Remove the power connection to the processor module and any cables between the modules and terminal boards.
3. Note and label cable locations.
4. Remove the PPC-2000 system from the DIN rail or panel.
5. Make sure the red top and bottom module latches on the processor module are in the unlocked position (pushed toward the back of the module.)

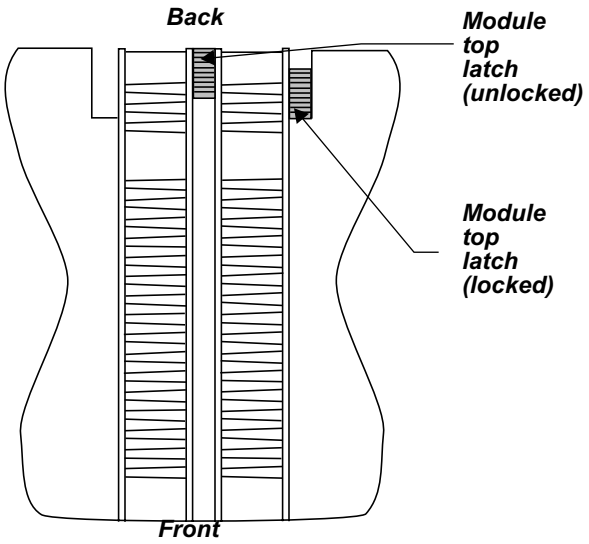


Figure 4.4 PPC Assembled Modules Top View

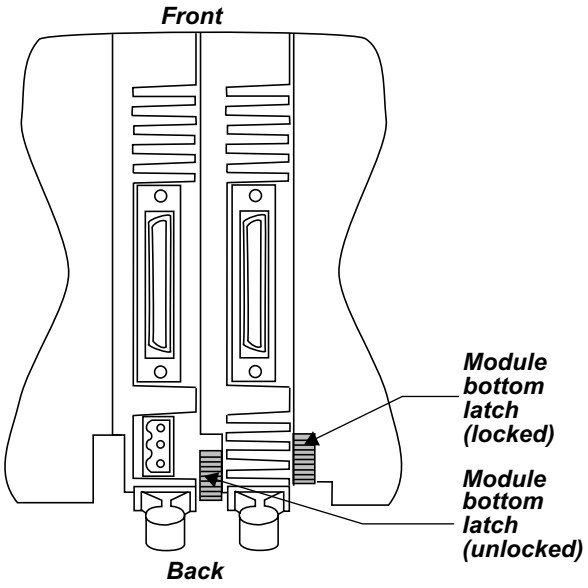


Figure 4.5 PPC Assembled Modules Bottom View

6. Gently rock and pull the modules apart.
7. Refer to *Figure 4.3 on page 144* to locate the battery on the controller board. Hold the controller board with the battery side facing down a few inches above a table or bench top. Pull up on the battery's spring tab and allow the battery to slip out of its housing and to the table top. Do not use a metal object (screwdriver, etc.) to remove the battery; this can short the + and – terminals. Replace battery with Duracell DL2032 (3 volt) only; contact Watlow Anafaze. Use of another battery may present a risk of fire or explosion. See *Battery Safety on page 11* for safety instructions.
8. Dispose of used battery promptly. Keep away from children.
9. Install the new battery.
10. Reassemble the controller.
11. When the module is properly seated, close the module latches on the processor by pushing the latch toward the front of the module. The two modules should be properly locked.
12. Replace the module on the DIN rail or panel.
13. Reconnect cables.
14. Power the unit.

15. Reset the controller and download the *AnaWin3* Snapshot. Refer to *Resetting Closed-Loop Control Parameters on page 156.*
16. Reload logic program stored variables.

Processor Module LEDs

Refer to the following descriptions of LED indicators when troubleshooting the Processor module.

- **Status Green LED On:** Normal condition with logic program stopped.
- **Status Green LED blinking four times per second, on briefly (230 ms Off, 20 ms On):** Normal condition with logic program running.
- **Status LED Off:** Indicates low power input.

  Corrective Actions:

  Check power connections.

  Measure power output from power supply.

  Disconnect I/O to check for excessive draw on power supply.
- **Status Green LED blinking four times per second, off briefly (50 ms Off, 200 ms On):** Seen at the beginning of logic program download while previous logic program is being erased.
- **Error 1 Orange LED and Error 2 Red LED on:** Indicates watchdog timeout — control program no longer running.

  Corrective Actions:

  Cycle power to PPC-2000 system. Perform RAM clear; see *Resetting Closed-Loop Control Parameters on page 156*.

  Replace Processor module.
- **Error 1 Orange LED on:** Indicates low battery or low voltage from the power supply.

  Corrective Actions:

  Check to make sure the voltage on the power supply is 12 to 28Vdc.

  Replace the battery. See *Battery Installation Procedures on page 145.*

PPC-2021 - 2025 Analog Input

Refer to the following descriptions of LED indicators when troubleshooting the analog input modules.

- **Error 3 Red LED blinking in sync with Green Status LED:** Indicates an open thermocouple.

  Corrective Actions:

  Verify that the correct sensor keys are installed correctly. See *Sensor Keys on page 46*.

  Check for an open thermocouple alarm and repair the corresponding thermocouple.

  If the input is not used, make sure it is not selected as the PV Source for any channel. Failed sensors are only reported for an input chosen as the PV Source for a channel.

- **Error 3 Red LED on or blinking but not in sync with Green Status LED:** Indicates common mode overvoltage. The cause could be either a transitional noise source or a steady state signal, such as an AC continuous source electrically tied into an input line.

  Corrective Actions:

  Locate the source of the noise and remove it.

  Remove ground loop problems.

  Check cabling - loose cables or input wires may cause intermittent noise.

- **Error 4 Red LED on:** Indicates a reference voltage overload. The precision 10Vdc source is being overdrawn. The LED will glow and increase with intensity as more current is overdrawn.

  Corrective Actions:

  If an AITB is used with an analog input module, check to make sure all key cards are inserted properly. Reverse insertion will cause the LED to light.

  If the 10V reference on the AITBs are used to power an external circuit (i.e., bridges, etc.) make sure the total current required does not exceed the specified limit. Refer to *Chapter 7, Specifications* for current information. These conditions will not harm the voltage source.

- **Green Status and Error 3 LEDs remains on:** Indicates two or more modules are set to the same address.

  Corrective Actions:

  Change the rotary switch settings so that each module has a unique address. Refer to *Module Addresses on page 17*.

- **Green Status LED remains off, on, or blinks incorrectly:** If analog input scanning is properly functioning, the green LED blinks. If the LED remains off, on, or blinks incorrectly, the module is not functioning.

  Corrective Actions:

  Make sure the rotary switch is set to the proper module address. Each module must have a unique address.

  Cycle power to PPC-2000 system.

  Check that the modules are connected properly; refer to *Module Assembly on page 24*.

  Perform a RAM clear; refer to *Resetting Closed-Loop Control Parameters on page 156*.

  Replace module.

- **LED indicators are OK but inputs are not seen:** Some or none of the wired input data is being transferred to the system. This may be an indication of a software or hardware problem.

  Corrective Actions:

  Check all interconnects (terminal blocks and SCSI connector).

  Check the input configuration in the *AnaWin3* software. Refer to *Chapter 3, Software Setup* for configuration information. Incorrect sensor type or wrong channel setup could be seen as incorrect data retention.

PPC-2030 Encoder In Analog Out

Refer to the following descriptions of LED indicators when troubleshooting the encoder input analog output module.

- **Green Status LED remains off, on, or blinks incorrectly:** If counter input scanning is properly functioning, the green LED blinks. If the LED remains off, on, or blinks incorrectly, the module is not functioning.

  Corrective Actions:

  Make sure the rotary switch is set to the proper module address. Each module must have a unique address.

  Cycle power to the PPC-2000 system.

  Check that the modules are connected properly; refer to *Module Assembly on page 24*.

  Perform a RAM clear; refer to *Resetting Closed-Loop Control Parameters on page 156*.

  Replace the module.

- **LED indicators are OK but pulse inputs are not seen or are incorrect:** Some or none of the wired input data is being transferred to the system. This may be an indication of a software or hardware problem.

  Corrective Actions:

  Ensure that inputs are wired to the correct pins on the high density cable connector or EITB.

  Check that the cable is connected to the correct port. The connector closest to the back carries pulse inputs 1 and 2. The connector closer to the face of the module carries pulse inputs 3 and 4.

  Make sure that the module has been configured properly for quadrature vs. single phase pulse inputs for each channel used. A quadrature encoder connected to an input configured as a single-phase will appear to operate backwards. Rotation that should increase the count decreases it, and vice versa. Refer to *Figure 2.5 on page 20* for instructions on setting switches for the encoder inputs.

- **LED indicators are OK but analog outputs are not seen or are incorrect:** Some or none of the wired input data is being transferred to the system. This may be an indication of a software or hardware problem.

  Corrective Actions:

  Ensure connections to terminal blocks are correct. Refer to *Analog Output Connections on page 60* for analog output wiring.

  Be sure the software configuration matches the hardware setup.

  Check that the jumpers are set correctly. See *PPC-2030 Jumper Settings on page 20.*

PPC-2040 Digital I/O

Refer to the following descriptions of LED indicators when troubleshooting the digital I/O module.

- **Green Status LED remains off, on, or blinks incorrectly:** When the module is correctly functioning the green LED blinks. If the LED remains off, on, or blinks incorrectly, the module may not be functioning correctly.

  Corrective Actions:

  Make sure the rotary switch is set to the proper module address. Each module must have a unique address.

  Cycle power to PPC-2000 system.

  Check that the modules are connected properly; refer to *Module Assembly on page 24*.

  Perform a RAM clear; refer to *Resetting Closed-Loop Control Parameters on page 156*.

  Replace the module.

- **Green Status LED is blinking but inputs and/or outputs are not reading correctly:**

  Corrective Actions:

  Check to make sure the I/O wiring is correct. See *Connecting I/O to the PPC-2040 on page 61.*

- **Red Error LED remains on:** Indicates at least one digital output is in an incorrect state. The cause could be an overloaded output or a failed output driver.

  Corrective Actions:

  Check the output circuits for shorts and repair if necessary.

  Check the load on the outputs to make sure that none of them exceeds 150mA.

  Check to make sure the I/O wiring is correct. See *Connecting I/O to the PPC-2040 on page 61*.

PPC-2050 Analog Out

Refer to the following descriptions of LED indicators when troubleshooting the analog output module.

- **Green Status LED remains off, on, or blinks incorrectly:** When the module is correctly functioning the green LED blinks. If the LED remains off, on, or blinks incorrectly, the module may not be functioning correctly.

  Corrective Actions:

  Make sure the rotary switch is set to the proper module address. Each module must have a unique address.

  Cycle power to PPC-2000 system.

  Check that the modules are connected properly; refer to *Module Assembly on page 24*.

  Perform a RAM clear; refer to *Resetting Closed-Loop Control Parameters on page 156*.

  Replace the module.

- **Green Status LED is blinking but outputs are not functioning correctly:**

  Corrective Actions:

  Check to make sure the I/O wiring is correct. See *Connecting Analog Outputs to the PPC-205x on page 67*.

  Check that the jumpers are set correctly. See *PPC-205x Jumper Settings on page 22*.

PPC-206x Digital Out

Refer to the following descriptions of LED indicators when troubleshooting the digital output module.

- **Green Status LED remains off, on, or blinks incorrectly:** When the module is correctly functioning the green LED blinks. If the LED remains off, on, or blinks incorrectly, the module may not be functioning correctly.

  Corrective Actions:

  Make sure the rotary switch is set to the proper module address. Each module must have a unique address.

  Cycle power to PPC-2000 system.

  Check that the modules are connected properly; refer to *Module Assembly on page 24*.

  Perform a RAM clear; refer to *Resetting Closed-Loop Control Parameters on page 156*.

  Replace the module.

- **Green Status LED is blinking but outputs are not functioning correctly:**

  Corrective Actions:

  Check to make sure the I/O wiring is correct. See *Connecting to the Relay Outputs on the PPC-206x on page 70*.

  Check to make sure the digital outputs are correctly configured. See *Digital Inputs and Outputs on page 154*.

PPC-207x Digital In

Refer to the following descriptions of LED indicators when troubleshooting the digital input module.

- **Green Status LED remains off, on, or blinks incorrectly:** When the module is correctly functioning the green LED blinks. If the LED remains off, on, or blinks incorrectly, the module may not be functioning correctly.

  Corrective Actions:

  Make sure the rotary switch is set to the proper module address. Each module must have a unique address.

  Cycle power to PPC-2000 system.

  Check that the modules are connected properly; refer to *Module Assembly on page 24*.

  Perform a RAM clear; refer to *Resetting Closed-Loop Control Parameters on page 156*.

  Replace the module.

- **Green Status LED is blinking but inputs are not working correctly**:

  Corrective Actions:

  Check to make sure the I/O wiring is correct. See *Connecting Digital Inputs to the PPC-207x on page 74*.

Troubleshooting and Corrective Actions

If the system fails to perform as expected, it may be necessary to perform one or more of the following procedures to discover the cause and restore normal operation.

Digital Inputs and Outputs

If a digital input or output doesn't seem to be working, check the following:

- Is the digital I/O point's **Direction** set correctly as an input or output? See *Digital I/O on page 132*.
- Is the **Logic** set correctly? Refer to *Digital I/O on page 132*.
- Is the output selected as an Output Destination for more than one function (e.g. a control output and an alarm output)? See *Channels on page 115* and *Alarms on page 123*.
- Is the digital I/O point associated with a variable set as an output in a logic program? Refer to the *LogicPro User's Guide*.
- Are the cable and wiring connections correct? See *Connecting I/O to the PPC-2010 on page 37, Connecting to the Relay Outputs on the PPC-206x on page 70*, and *Connecting Digital Inputs to the PPC-207x on page 74*.
- Is leakage current from one of the configurable I/O points such that a device is being switched on or partly on? See *Connecting Digital Outputs on page 41*.
- Is the field I/O device powered? Note digital outputs on the PPC-2010 and PPC-2040 sink current. That current must be sourced by an external device that is referenced to the PPC's common. See *Connecting Digital Outputs on page 41* for the PPC-2010 and *Connecting Digital Outputs on page 65* for the PPC-2040.

Process Variable

If the Process Variable is not updating, check the following:

- Is a valid analog input selected as the **PV Source**? See *Channels on page 115*.
- Is the input corresponding to the **PV Source** updating as expected? If not check LEDs on the associated module, See corresponding module section in this chapter.
- Is the input wiring correct? See *Connecting I/O to the PPC-2010 on page 37, Connecting Analog Inputs to the PPC-2021 — 2025 on page 45, Connecting Encoders and Analog Outputs to the PPC-2030 on page 55, or Connecting to the Relay Outputs on the PPC-206x on page 70*.

Communications

If communications has never worked, check the following:

- Is the PPC-2010 Processor running? The RX LED on the port lights as the controller receives signals. The TX LED lights if the controller receives a valid Modbus request. This indicates a response being sent by the PPC.
- Is the communications cable in the correct connector on the PPC-2010?
- Is the other wiring correct? See *Connecting Communication Ports on page 78*.
- Is the RS-232/485 converter configured and working properly? See *Connecting Communication Ports on page 78* and the converter documentation.
- Are the communications parameters set the same in both the PPC-2000 and the host device or software? See *Modbus Network Address on page 86*.
- Is the host device or software configured properly? See the appropriate user documentation.
- Is the correct communications port selected? See the appropriate user documentation.

If communications was working and has failed, check these things:

- Is the PPC-2010 Processor running? The RX LED on the port lights as the controller receives signals. The TX LED lights if the controller receives a valid Modbus request. This indicates a response being sent by the PPC.
- Has the rotary switch setting on the Processor Module been changed? See *Modbus Network Address on page 86*.
- Is the wiring correct? See *Connecting Communication Ports on page 78*.
- Have any of the communications port settings on the computer been changed? See the appropriate user documentation.
- Is the RS-232/485 converter working properly?

If one of the programmable communications parameters may have changed, establishing communications by following these steps will demonstrate that all the components are functioning and connections are correct:

CAUTION! ***Do not perform this procedure at a time during which closed-loop control and logic program outputs should not be turned off.***

1. Remove power from the PPC-2000 system.
2. Set the rotary switch on the Processor module to position **H**.
3. Power up the PPC-2000 system.
4. Set the communications parameters used by the host device or software to the appropriate values for setting **H**:
   Network address: **1**
   Baud rate: **19.2 kbaud**
   Parity: **Even**
   Data bits: **8**
   Stop bits: **1**
5. Attempt to communicate.

   If the PPC-2000 still will not communicate and all other components and settings have been verified, contact technical support at the number in the front of this manual.

Resetting Closed-Loop Control Parameters

To restore all the closed-loop control, alarm, global and I/O parameters to their factory default settings, perform the following procedure:

NOTE! ***This procedure erases ALL user settings including I/O assignments and restores all parameters to the factory defaults, and all retained logic program values are reset. Make a record of all settings you may wish to restore before performing this procedure. A Snapshot may be made in AnaWin3 to record closed-loop control parameters for future downloading.***

This procedure resets the programmable communications parameters and restores them to the factory defaults. Make a record of all settings you may wish to restore before performing this procedure.

After performing the following procedure, refer to *Setting Programmable Modbus Addresses on page 87*, if necessary, to reprogram the Modbus address or baud rate.

CAUTION! ***Do not perform this procedure at a time during which closed-loop control and logic program outputs should not be turned off.***

1. Remove power from the PPC-2000 system.
2. Note the setting of the rotary switch on the Processor Module.
3. Set the rotary switch to position **E**.
4. Power up the PPC-2000 system.
5. Wait five seconds.
6. Remove power from the PPC-2000 system.
7. Set the rotary switch back to the position noted in *Step 2*.
8. Power up the PPC-2000 system.

Disabling Control

If the settings in a PPC are not known it may be desirable to power up the system in a state that will not generate outputs. The following procedure describes how to power up the PPC-2000 such that the closed-loop control and logic program, if any, do not automatically begin:

CAUTION! ***Do not perform this procedure at a time during which closed-loop control and logic program outputs should not be turned off.***

1. Remove power from the PPC-2000 system.
2. Note the setting of the rotary switch on the Processor Module.
3. Set the rotary switch to position **H**.
4. Power up the PPC-2000 system.
5. Set channels to the desired control modes to begin closed-loop control.
6. Click the **Start Logic** button on the **PPC Globals** screen to start the logic program, if desired.

5

LogicPro and Modbus Reference

Overview

This chapter is designed for engineers and technicians tasked with setting up third-party software or an operator interface terminal for operating and monitoring of a PPC System. The parameter addressing described in this chapter applies to firmware versions 2.0 (released 9/1/99) and later. This chapter provides information needed to address parameters when writing programs using *LogicPro*. For instructions on operating the Watlow Anafaze software, *AnaWin3*, with your PPC system, refer to *Chapter 3, Software Setup*.

Text Conventions in the Database Sections

Table 5.1 shows the parameter names and abbreviations as seen in *AnaWin3*. Parameter names are shown as a reference only for programming purposes.

Table 5.1 Parameter Names & Abbreviations

Abbreviation	Parameter
SP	Setpoint
PV	Process Variable
HP	High Process
LP	Low Process
HD	High Deviation
LD	Low Deviation

A special font or typeface is used to indicate parameter names and text seen in the *AnaWin3* screens.

Process Variable Low (PV Lo)
Set this parameter to the value displayed when the signal is at the level set in **Input Signal Low (Input Signal Lo)**.

Figure 5.1 Sample Text

The words **Process Variable Low** and **Input Signal Low** represent parameter names. The words **(PV Lo)** and **(Input Signal Lo)** are the abbreviated terms seen in *AnaWin3*. These abbreviations are shown for reference in this chapter only when the *AnaWin3* name differs from the listed parameter names.

The PPC-2000 Database

The PPC stores setpoints and other control parameters along with process variable values and digital I/O states in its database. The database is analogous to a set of tables. Parameters form the columns of the tables. *AnaWin3*, third-party HMI software, operator interface terminals and *LogicPro* programs access these process parameters and data in the database.

Think of the database as a series of tables. Each table holds the values of a different set of parameters: analog inputs; channels; digital I/O; analog outputs; soft integers; soft booleans; and globals. In each table the columns represent parameters and the rows represent analog inputs, or channels, or digital I/O and so on.

For example, in the analog input table, the columns represent the analog input parameters such as **Input Value**, **Input Type**, and **Input Filter**. Each row holds the settings of each of these parameters for a particular analog input.

Table 5.2 Example Database Table

	Input Value	Input Type	Input Filter
Input 1	2089	44	3
Input 2	2089	44	3
Input 3	2089	44	3

The cells in the database tables are referred to as registers. There are two types of registers in the database: bit registers and word registers. Bit registers hold a single bit and word registers hold 16-bit integers.

These registers may be accessed by software running on a PC or by an operator interface terminal or by a logic program running on the PPC itself. Some parameters are read only, but others may be read or changed.

Data Table Organization

The datatable is organized according to the Modbus standard for PLC memory. Memory is divided into four sections by size and function. The Modbus specification allows for up to 9,999 registers for each section. Some registers are not available in the PPC-2000. Consult the parameter tables in this chapter to determine which registers are available. Also, the usage of some registers in the PPC-2000 differs from standard PLC usage; for instance, coils are used for digital input status.

Coils

Coils are bit registers. Each have a value of 1 or 0. Software interfaces may read or write the values stored in these registers. The modbus addresses for Coils range from 0001 to 9999 (decimal).

Inputs

Inputs are bit registers. Each has a value of 1 or 0. Software interfaces may read but not write the values stored in these registers. The modbus addresses for Inputs range from 10001 to 19999 (decimal).

Holding Registers

Holding registers are 16-bit size; they store values from -32,768 to 32,767. Software interfaces may read or write the values stored in these registers. Some of the PPC-2000 parameters stored in holding registers have more limited ranges than the register size. The modbus addresses for holding registers range from 40001 to 49999

Input Registers

Input registers are 16-bit in size; they store values from -32,768 to 32,767. Software interfaces may read but not write the values stored in these registers. The PPC-2000 uses these registers to store analog and encoder input values. The Modbus addresses for the input registers range from 30001 to 39999.

Accessing the Database with Modbus

Each register can be individually accessed using software and the Modbus communications protocol via a serial port on the processor module because each register has a unique Modbus address. The Modbus address for each parameter is given in sections *Analog and Counter Input Parameters in the Database on page 163* through *Global Parameters in the Database on page 206*.

Because the database is quite large, it is impractical and undesirable to list each Modbus address. Instead, the first and last addresses for each parameter are listed. Individual registers are addressed by determining the offset from the first address corresponding to the particular input, output, or channel.

For example, in a PPC-2000 system with 32 analog inputs on one module, the register addresses for inputs 1-32 are 30601 to 30632. The measured value corresponding to the first analog input is stored at address 33601. The value of the second input is stored at address 33602. The value of input 26 is stored at address 30626, and so on. The *Database Offset* for the first analog input is said to be 1, for the second input is 2, and for the 26th input is 26. In each section describing a database table, the *Database Offset* scheme is explained.

How LogicPro Accesses the Database

Logic programs can be written and downloaded using *LogicPro*. Typically, such programs access digital and/or analog I/O and may also access other values stored in the database. Because the user-written logic program resides in the processor module, it does not use the serial port or Modbus to access the database. Instead, each register can be accessed by logic program variables using one of the I/O drivers supplied with *LogicPro*.

Some drivers correspond to modules. These drivers are used to access the digital and analog I/O values corresponding to the field devices connected to each module. The *LogicPro* IO Physical Address is used in conjunction with these module-specific drivers to use a digital or analog I/O value in a logic program.

For example, the value measured by a thermocouple attached to the first input on an Analog In module with address 2 is accessed with the Analog_In_202x driver and the Logic Pro IO Physical Address 2.1.

The *LogicPro* Database driver facilitates access to all database parameters. Because the database is large, it impractical and undesirable to list each *LogicPro* address. Instead, the parameter number and database offset range for each parameter are supplied. Individual registers are addressed by coupling the parameter number and the database offset corresponding to the particular input, output, or channel.

For example, the parameter number for setpoint, found in *Table 5.12 on page 174*, is 95. The database offset for channel parameters is channel number. So using the Database IO Driver supplied with *LogicPro* the IO Physical Address for the setpoint of channel 23 is 95.23.

Refer to the LogicPro User's Guide for detailed instructions on using the IO Drivers and creating logic programs. Refer to this chapter of this manual for specific LogicPro IO Physical Addresses, and parameter numbers.

Analog and Counter Input Parameters in the Database

Analog input parameters determine how measurements of signals from sensors attached to modules are read and scaled into engineering units for use by closed-loop control channels, monitor channels and logic programs. These parameters can be read and set by Modbus devices and logic programs.

Accessing Analog and Counter Input Parameters with Modbus

To access analog and counter input parameters, use the database offset as the Modbus address offset. See *Table 5.3 on page 164* through *Table 5.6 on page 166* for a list of the database offsets and Modbus addresses corresponding to the analog and counter inputs.

Table 5.8 on page 168 lists first and last Modbus addresses for each input parameter. Use these addresses when accessing analog or counter input parameters with third-party software or operator interface terminals.

Accessing Analog and Counter Input Parameters with *LogicPro*

To access counts, frequencies, and analog input values measured by the modules, use the appropriate IO Driver in *LogicPro*. There are separate drivers for each type of module. The driver requires an IO Physical Address to determine which analog input to read on the module. See *Table 5.3 on page 164* through *Table 5.6 on page 166* to determine *LogicPro* IO Physical Address.

The *LogicPro* IO Physical Addresses are listed by input according to the default Input names as seen in *AnaWin3*. To correlate the *AnaWin3* name with the hardware connection see *Table 2.10 on page 39, Table 2.12 on page 47, Table 2.15 on page 56, Table 2.16 on page 56, and Table 2.19 on page 60*.

When a logic program variable accesses an analog input parameter, the parameter number (#) and the Database Offset are used in conjunction with *LogicPro's* Database IO Driver.

The IO Physical Address is constructed from the parameter number and the database offset.

See the *LogicPro User's Guide* for specific instructions on addressing analog and encoder input parameters.

See *Table 5.3 below* through *Table 5.6 on page 166* for a list of the database offsets for each analog and counter input. See *Table 5.8 on page 168* for analog input parameter numbers.

Analog Input Numbers and Address Offsets

Table 5.3 below through *Table 5.6 on page 166* list the *LogicPro* IO Physical Addresses, Database Offsets and sample Modbus addresses corresponding to each analog and counter input. The sample Modbus addresses are for the **Input Value**.

Table 5.3 Addresses for Analog Inputs on the PPC-202x Modules

AnaWin3 Name[1] (Input Spread-sheet)	LogicPro I/O Physical Address		Modbus Addressing	
	Analog_In_202x IO Driver[2]	Database IO Driver[3]	Database Offset	Sample Address
PPC1:AI 1.1	1.1	#.1	1	30801
PPC1:AI 1.2	1.2	#.2	2	30802
⋮	⋮	⋮	⋮	⋮
PPC1:AI 1.32	1.32	#.32	32	30832
PPC1:AI 2.1	2.1	#.33	33	30833
PPC1:AI 2.2	2.2	#.34	34	30834
⋮	⋮	⋮	⋮	⋮
PPC1:AI 2.32	2.32	#.64	64	30864
PPC1:AI 3.1	3.1	#.65	65	30865
PPC1:AI 3.2	3.2	#.66	66	30866
⋮	⋮	⋮	⋮	⋮
PPC1:AI 3.32	3.32	#.96	96	30896
PPC1:AI 4.1	4.1	#.97	97	30897
PPC1:AI 4.2	4.2	#.98	98	30898
⋮	⋮	⋮	⋮	⋮
PPC1:AI 4.32	4.32	#.128	128	30928

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of analog input naming.

[2]Use this address with the *Analog_In_202x IO Driver* when addressing **Input Value.**

[3]Use this address with the *Database IO Driver* when addressing input parameters other than **Input Value**. Replace the # with the parameter number (#) from *Table 5.8 on page 168* for the parameter you want to address.

Table 5.4 Addresses for Encoder Inputs on the PPC-2030 Encoder In Analog Out Module

AnaWin3 Name[1] (Input Spread-sheet)	LogicPro I/O Physical Address		Modbus Addressing	
	Encoder_Analog_ 2030 IO Driver[2]	Database IO Driver[3]	Database Offset	Sample Address
PPC1:EIAO 11.1.1 C	11.1.1	#.129	129	30929
PPC1:EIAO 11.2.1 F	11.2.1	#.130	130	30930
PPC1:EIAO 11.1.2 C	11.1.2	#.131	131	30931
PPC1:EIAO 11.2.2 F	11.2.2	#.132	132	30932
PPC1:EIAO 11.1.3 C	11.1.3	#.133	133	30933
PPC1:EIAO 11.2.3 F	11.2.3	#.134	134	30934
PPC1:EIAO 11.1.4 C	11.1.4	#.135	135	30935
PPC1:EIAO 11.2.4 F	11.2.4	#.136	136	30936
PPC1:EIAO 12.1.1 C	12.1.1	#.137	137	30937
PPC1:EIAO 12.2.1 F	12.2.1	#.138	138	30938
PPC1:EIAO 12.1.2 C	12.1.2	#.139	139	30939
PPC1:EIAO 12.2.2 F	12.2.2	#.140	140	30940
PPC1:EIAO 12.1.3 C	12.1.3	#.141	141	30941
PPC1:EIAO 12.2.3 F	12.2.3	#.142	142	30942
PPC1:EIAO 12.1.4 C	12.1.4	#.143	143	30943
PPC1:EIAO 12.2.4 F	12.2.4	#.144	144	30944
PPC1:EIAO 13.1.1 C	13.1.1	#.145	145	30945
PPC1:EIAO 13.2.1 F	13.2.1	#.146	146	30946
PPC1:EIAO 13.1.2 C	13.1.2	#.147	147	30947
PPC1:EIAO 13.2.2 F	13.2.2	#.148	148	30948
PPC1:EIAO 13.1.3 C	13.1.3	#.149	149	30949
PPC1:EIAO 13.2.3 F	13.2.3	#.150	150	30950
PPC1:EIAO 13.1.4 C	13.1.4	#.151	151	30951
PPC1:EIAO 13.2.4 F	13.2.4	#.152	152	30952
PPC1:EIAO 14.1.1 C	14.1.1	#.153	153	30953
PPC1:EIAO 14.2.1 F	14.2.1	#.154	154	30954
PPC1:EIAO 14.1.2 C	14.1.2	#.155	155	30955
PPC1:EIAO 14.2.2 F	14.2.2	#.156	156	30956
PPC1:EIAO 14.1.3 C	14.1.3	#.157	157	30957
PPC1:EIAO 14.2.3 F	14.2.3	#.158	158	30958
PPC1:EIAO 14.1.4 C	14.1.4	#.159	159	30959
PPC1:EIAO 14.2.4 F	14.2.4	#.160	160	30960

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of analog input naming. C=Counter input, F=Frequency input.

[2]Use this address with the *Encoder_Analog_2030 IO Driver* when addressing **Input Value**.

[3]Use this address with the *Database IO Driver* when addressing input parameters other than **Input Value**. Replace the # with the parameter number (#) from *Table 5.8 on page 168* for the parameter you want to address.

Table 5.5 Addresses for Counter Inputs on the PPC-2010 Processor Module

AnaWin3 Name[1] (Input Spreadsheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Processor_2010 IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:Proc 0.1.1 C	0.1.1	#.161	161	30961
PPC1:Proc 0.2.1 F	0.2.1	#.162	162	30962

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of analog input naming. C=Counter input, F=Frequency input.

[2]LogicPro Variable Type must be INT and IO Size must be WORD.

[3]Use this address with the *Processor_2010 IO Driver* when addressing the count or frequency **Input Value.**

[4]Use this address with the *Database IO Driver* when addressing input parameters other than **Input Value**. Replace the # with the parameter number (#) from *Table 5.8 on page 168* for the parameter you want to address.

Soft inputs are used when the **Process Variable Source** of a channel must be a register to which a logic program can write. Channel Output registers are used as the **Setpoint Source** for the secondary cascade channel.

Table 5.6 Addresses for Soft Inputs and Channel Outputs

AnaWin3 Name[1] (Input Spreadsheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Soft_Input IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:Soft Input 1	1	#.165	165	30965
PPC1:Soft Input 2	2	#.166	166	30966
⋮	⋮	⋮	⋮	⋮
PPC1:Soft Input 48	48	#.212	212	31012
PPC1:Channel 1 Output	n/a	#.215	215	31015
PPC1:Channel 2 Output		#.216	216	31016
⋮		⋮	⋮	⋮
PPC1:Channel 48 Output		#.262	262	31062

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of analog input naming.

[2]LogicPro Variable Type must be INT and IO Size must be WORD.

[3]Use this address with the *Soft_Input IO Driver* when addressing the **Input Value** of a Soft Input.

[4]Use this address with the *Database IO Driver* when addressing other input parameters. Replace the # with the parameter number (#) from *Table 5.8 on page 168* for the parameter you want to address.

Table 5.7 Addresses for Encoder Inputs on the PPC-2040 Digital I/O Modules

AnaWin3 Name[1] (Input Spreadsheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Digital_IO_2040 IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:DIO 21.1.1 C	21.1.1	#.301	301	31101
PPC1:DIO 21.2.1 F	21.2.1	#.302	302	31102
PPC1:DIO 21.1.2 C	21.1.2	#.303	303	31103
PPC1:DIO 21.2.2 F	21.2.2	#.304	304	31104
PPC1:DIO 22.1.1 C	22.1.1	#.305	305	31105
PPC1:DIO 22.2.1 F	22.2.1	#.306	306	31106
PPC1:DIO 22.1.2 C	22.1.2	#.307	307	31107
PPC1:DIO 22.2.2 F	22.2.2	#.308	308	31108
PPC1:DIO 23.1.1 C	23.1.1	#.309	309	31109
PPC1:DIO 23.2.1 F	23.2.1	#.310	310	31110
PPC1:DIO 23.1.2 C	23.1.2	#.311	311	31111
PPC1:DIO 23.2.2 F	23.2.2	#.312	312	31112
PPC1:DIO 24.1.1 C	24.1.1	#.313	313	31113
PPC1:DIO 24.2.1 F	24.2.1	#.314	314	31114
PPC1:DIO 24.1.2 C	24.1.2	#.315	315	31115
PPC1:DIO 24.2.2 F	24.2.2	#.316	316	31116
PPC1:DIO 25.1.1 C	25.1.1	#.317	317	31117
PPC1:DIO 25.2.1 F	25.2.1	#.318	318	31118
PPC1:DIO 25.1.2 C	25.1.2	#.319	319	31119
PPC1:DIO 25.2.2 F	25.2.2	#.320	320	31120
PPC1:DIO 26.1.1 C	26.1.1	#.321	321	31121
PPC1:DIO 26.2.1 F	26.2.1	#.322	322	31122
PPC1:DIO 26.1.2 C	26.1.2	#.323	323	31123
PPC1:DIO 26.2.2 F	26.2.2	#.324	324	31124

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Inputs on page 127* for a full explanation of analog input naming. C=Counter input, F=Frequency input.

[2]LogicPro Variable Type must be INT and IO Size must be WORD.

[3]Use this address with the *Digital_IO_2040 IO Driver* when addressing the count or frequency **Input Value**.

[4]Use this address with the *Database IO Driver* when addressing input parameters other than **Input Value**. Replace the # with the parameter number (#) from *Table 5.8 on page 168* for the parameter you want to address.

Analog and Encoder Input Parameters

Table 5.8 lists the parameter number (#), range, and first and last Modbus addresses for each analog input parameter. These values are used when accessing analog input parameters with third-party software, operator interface terminals or *LogicPro* programs.

The range of some of the parameters depends on which input type is selected. See *Table 5.10 on page 170* for a list of the input types and their corresponding ranges. While all the input parameter values are 16-bit integers, many, such as **Input Type**, are numerical representations of settings that have special meanings to the controller. See the tables under the corresponding parameter descriptions for explanations of the possible settings.

Note that while any analog input can be assigned to any control channel, the channel number that an input is assigned to has no effect on the input variable's data table address.

Table 5.8 Input Parameters

Parameter	#	Range	Modbus Address	Hex Address	Notes
Sample Time	74	200-700 ms typical	31801-32200	708-897	
Input, Raw Counts	72	0-65535	31201-31600	4B0-63F	
Input Value	67	-32768 to +32767	30801-31200	320-4AF	
Input Status	75	0-16	32201-32600	898-A27	See *Table 5.9*
Input Type	60	0-60	41751-42150	6D6-865	See *Table 5.9*
Input Filter	61	0-255	42151-42550	866-9F5	
Temperature Scale	64	0-1	42951-43350	B86-D15	See *Table 5.11*
Input Signal Low	71	-32768 to +32767	44551-44950	11C6-1355	See *Table 5.11*
Input Signal High	70	-32768 to +32767	44151-44550	1036-11C5	See *Table 5.11*
Process Variable Low	69	-32768 to +32767	43751-44150	EA6-1035	
Process Variable High	68	-32768 to +32767	43351-43750	D16-EA5	
PV Offset/ Counter Reset	78	-32768 to +32767	44951-45350	1356-14E5	

Sample Time

Time, in milliseconds, between scans for this input, as last reported by the analog input driver. This is a read-only parameter.

Input, Raw Counts

Actual raw counts read during the last scan for analog and counter inputs.

Input Value

Fully linearized and filtered input reading in engineering units: degrees for temperature inputs or specified engineering units for linear inputs. Input values are copied to the process variable register for channels with this input chosen as the **Process Variable Source**. Units depend on **Input Type**.

Input Status

This read-only register contains information about the sensor. *Table 5.9* lists and describes the possible values for the parameter.

Table 5.9 Input Status

Value	Input Status
0	No problems
1	Open sensor
2	Shorted RTD sensor
8	Common mode overvoltage. There is too much noise on the sensor to make an accurate reading.
16	Ambient temperature error. Temperature is outside controller's operating range.

Input Type

Specify the sensor type. *Table 5.10 on page 170* shows the default sensor ranges for the various inputs. All **Input Value** registers store integers. In order to provide the desired precision for many **Input Types**, the integer stored in the register may be in tenths of a degree or hundredths of a millivolt. For example, if an input is set to input type 6 and the **Input Value** register contains a value of 2506, the actual measure value is 25.06mV because the values in the register are in units of hundredths of a millivolt.

Table 5.10 Input Types

Value	AnaWin3 Name	Range	Units
0	**(No Input)**	N/A	N/A
1	**Volts: -1 to 10Vdc**	-1000 to 10000	mV
2	**Volts: -0.5 to 5Vdc**	-500 to 5000	mV
3	**Volts: -0.1 to 1Vdc**	-1000 to 10000	0.1mV
4	**Spare**	N/A	N/A
5	**Volts: -50 to 500mVdc**	-500 to 5000	0.1mV
6	**Volts: -10 to 100mVdc**	-1000 to 10000	0.01mV
7	**Volts: -5 to 50mVdc**	-500 to 5000	0.01mV
8-9	**Spare**	N/A	N/A
10	**Linear -1 to 10 (V)**	-1000 to 10000	mV
11	**Linear -0.1 to 1 (V)**	-1000 to 10000	0.1mV
12	**Linear -10 to 100 (mV)**	-1000 to 10000	0.01mV
13	**Linear -2 to 20 (mA)**	-2000 to 20000	0.01mA
14	**Linear (Counts)**	-32767 to 32768	Counts
15	**Linear 0 to 10k (Hz)**	-32767 to 32768	Hz
16	**Linear 0 to 300 (Hz)**	-32767 to 32768	0.01Hz
17-19	**Spare**	N/A	N/A
20	**Current: 0-20mA**	0 to 20000	0.1mA
21	**Current: 4-20mA**	40 to 20000	0.1mA
22	**Spare**	N/A	N/A
23	**Counter**	-32767 to 32768	counts
24	**Frequency**	-10000 to 10000	Hz
25-39	**Spare**	N/A	N/A
31	**100K ohm Thermistor**	-2500 to 32760°F	0.01°F
40	**B T/C (1°F)**	32 to 3308	1°F
41	**C T/C (1°F)**	32 to 4200	1°F
42	**D T/C (1°F)**	32 to 4200	1°F
43	**E T/C (0.1°F)**	-4540 to 12210	0.1°F
44	**J T/C (0.1°F)**	-3460 to 15980	0.1°F
45	**K T/C (0.1°F)**	-4540 to 22490	0.1°F
46	**N T/C (0.1°F)**	-4540 to 23720	0.1°F
47	**R T/C (0.1°F)**	-580 to 32150	0.1°F
48	**S T/C (0.1°F)**	-580 to 32150	0.1°F
49	**T T/C (0.1°F)**	-4540 to 7520	0.1°F
50	**F T/C (Platinel2)**	320 to 22500	0.1°F
51	**G T/C (1°F)**	32 to 4200	1°F
52-57	**Spare**	N/A	N/A
58	**J T/C without open detection**	-3460 to 15980	0.1°F
59	**K T/C without open detection**	-4540 to 22490	0.1°F
60	**RTD, 100 Ohm Plat**	-4180 to 5210	0.1°F
61	**RTD, 100 Ohm Plat High**	-4180 to 15620	0.1°F

NOTE! ***The counter and frequency inputs update four times per second (4Hz), except the Linear 0 to 300 (Hz) input type, which updates once every 25 seconds (.04Hz). The update rate of all other input types depends on the module. See Chapter 7, Specifications.***

Input Filter

This parameter determines the time constant for the filter applied during the conversion of **Input, Raw Counts** to **Input Value**. The input value responds to a step change by going to approximately 2/3 of its final value, within the number of scans set here. A larger number yields a slower, or more damped, response to changes as measured by the sensor.

Temperature Scale

This register sets the units used during the conversion of **Input, Raw Counts** to **Input Value**. This parameter applies only to temperature sensor input types. *Table 5.11* lists and describes the possible settings.

Table 5.11 Temperature Scale Conversion

Value	Temperature Scale
0	degrees F
1	degrees C

Input Signal Low (Input Signal Lo)

This is the input signal level that corresponds to the low process value set in **Process Variable Low** (see below). For custom linear inputs, this parameter is the lowest level signal the sensor or encoder will supply. Typically, this corresponds to the lowest process variable to be measured. The units and range for this parameter correlate to the selected **Input Type**. See *Table 5.10 on page 170*. See *Setting Input Signal Lo and Input Signal Hi on page 99* for detailed information.

Input Signal High (Input Signal Hi)

This is the input signal level that corresponds to the high process value set in **Process Variable High** (see below). For custom linear inputs, this parameter is the highest level signal the sensor or encoder will supply. Typically, this corresponds to the highest process variable to be measured. The units and range for this parameter correlate to the selected **Input Type**. See *Table 5.9*. See *Setting Input Signal Lo and Input Signal Hi on page 99* for detailed information.

Process Variable Low (PV Lo)

Set this register to the value to be displayed when the signal is at the level set in **Input Signal Low** (see above). See *Setting PV Lo and PV Hi on page 99* for detailed information.

Process Variable High (PV Hi)

Set this register to the value to be displayed when the signal is at the level set in **Input Signal High** (see above). See *Setting PV Lo and PV Hi on page 99* for detailed information.

PV Offset/Counter Reset

This value is added to the scaled input before it is entered in the **Input Value** register for temperature sensor input types (T/Cs and RTDs). For counter input types, when this register is written to, the count is set equal to the value written. This can be used to reset or pre-load counter values.

Channel Parameters in the Database

Channel parameters determine the behavior of the PPC's 48 closed-loop control channels. Channels are not inherently associated with any particular hardware I/O. The user associates a channel with a particular input and output by setting the **Process Variable Source** and the **Output Destination** parameters.

Channel numbers are, therefore, selected at the users discretion. Each channel does, however, have many parameters associated with it. It is up to the user to make sure the channel parameters are appropriate for closed-loop control.

Accessing Channel Parameters with Modbus

For channel parameters the Modbus address offsets correspond to the channel numbers. (Note that channel numbers are not affected by the analog input selected as the **Process Variable Source** or the output selected as the **Output Destination (Heat/Cool Output Dest)**.)

For example, register addresses for **Heat Proportional Band (Heat Prop Band)** for channels 1-48 are 43101 to 43148. Channel 1's **Heat Proportional Band** is stored at address 43101. Channel 2's **Heat Proportional Band** is stored at address 43102, and so on.

Table 5.12 on page 174 lists first and last Modbus addresses for each channel parameter. Use these addresses when accessing channel parameters with third-party software or operator interface terminals.

Accessing Channel Parameters with *LogicPro*

When a logic program variable accesses a channel parameter, the parameter number (#) and the channel number (database offset) are used in conjunction with the *LogicPro's* Database IO Driver. The IO Physical Address is constructed from the parameter number and the channel number.

See the *LogicPro User's Guide* for specific instructions on addressing channel parameters. See *Table 5.12 on page 174* for channel parameter numbers.

Channel Parameters for Heat and Cool Outputs

Each of the PPC's closed-loop control channels may have one or two outputs (heat and/or cool). Many of the channel parameters may be independently set for the heat and cool outputs and, therefore, have two registers in the database. For example, **Heat Proportional Band (Heat Prop Band)** is the proportional band for the heat output and **Cool Proportional Band (Cool Prop Band)** is the proportional band for the cool output.

Channel Parameters

Table 5.12 lists the parameter number (#), range, and first and last Modbus addresses for each channel parameter. These values are used when accessing channel parameters with third-party software, operator interface terminals or *LogicPro* programs.

The range of some of the parameters is equal to the range of the input type selected for the channel. See *Table 5.10 on page 170* for a list of the input types and their corresponding ranges. While all the channel parameter values are 16-bit integers, many, such as **Control Mode**, are numerical representations of settings that have special meanings to the controller. See the tables under the corresponding parameter descriptions for explanations of the possible settings.

Table 5.12 Channel Parameters

Parameter	#	Range	Modbus Address	Hex Address	Notes
Process Variable Source	99	0-324	46101-46150	17D4-1805	
Process Variable	96		33001-33050	BB8-BE9	*See explanation on p. 179*
Setpoint	95		46051-46100	17A2-17D3	
Control Mode	1	0-3	40001-40050	0-31	See *Table 5.18 on page 180*
PID Parameters					
Heat Feedback Value	13	0-1000	30151-30200	96-C7	
Cool Feedback Value	25	0-1000	30351-30400	15E-18F	
Heat Proportional Band	3		40101-40150	64-95	See explanation on p. 180
Cool Proportional Band	15		40451-40500	1C2-1F3	
Heat Integral	4	0-600	40151-40200	96-C7	
Cool Integral	16	0-600	40501-40550	1F4-225	
Heat Derivative	5	0-255	40201-40250	C8-F9	
Cool Derivative	17	0-255	40551-40600	226-257	
Spread	2		40051-40100	32-63	See explanation on p. 181
Heat Manual Reset	8	0-1000	40301-40350	12C-15D	
Cool Manual Reset	20	0-1000	40601-40650	258-289	
Control Type	19	0-4	46401-46450	1900-1931	
Setpoint Source	7	0-324	40251-40300	FA-12B	See explanation on p.182
Setpoint Ratio	9	-30000-30000	40351-40400	15E-18F	
Setpoint Offset	14	-32767-32767	40401-40450	190-1C1	See explanation on p. 182
Maximum Setpoint	26		46451-46500	1932-1963	See explanation on p. 182
Minimum Setpoint	27		46501-46550	1964-1995	See explanation on p. 182
Output Parameters					
Heat Output Type	30	0-25	40651-40700	28A-2BB	See *Table 5.19 on page 183*
Cool Output Type	45	0-25	41201-41250	2BCO-2BF1	See *Table 5.19 on page 183*
Heat Output Cycle Time	32	1-255	40751-40800	2EE-31F	
Cool Output Cycle Time	47	1-255	41301-41350	514-545	
Heat Scale Lo	38	0-1000	41051-41100	41A-44B	
Cool Scale Lo	53	0-1000	41601-41650	2D50-2D81	
Heat Scale Hi	39	0-1000	41101-41150	2B5C-2B8D	
Cool Scale Hi	54	0-1000	41651-41700	672-6A3	
Heat Curve	35	0-2	40901-40950	384-3B5	See *Table 5.21 on page 184*
Cool Curve	50	0-2	41451-41500	5AA-5DB	See *Table 5.21 on page 184*
Auto Heat Limit	33	0-1000	40801-40850	320-351	
Auto Cool Limit	48	0-1000	41351-41400	546-577	
Heat Limit Time	34	0-32767	40851-40900	352-383	

Parameter	#	Range	Modbus Address	Hex Address	Notes
Cool Limit Time	49	0-32767	41401-41450	578-5A9	
Sensor Fail Heat%	37	0-1000	41001-41050	3E8-419	
Sensor Fail Cool%	52	0-1000	41551-41600	60E-63F	
Heat Output Filter	31	0-100	40701-40750	2BC-2ED	
Cool Output Filter	46	0-100	41251-41300	4E2-513	
Heat Output%	36	0-1000	40951-41000	3B6-3E7	
Cool Output%	51	0-1000	41501-41550	5DC-60D	
Heat Output Destination	40	0-4102	41151-41200	47E-4AF	
Cool Output Destination	55	0-4102	41701-41750	6A4-6D5	
Alarm Parameters					
Alarm Status Flags	82	*	45451-45500	154A-157B	See *Table 5.28 on page 190*
Alarm Control Flags	85	*	45601-45650	15E0-1611	See Table 5.30 on page 192
Alarm Acknowledge Flags	88	*	45751-45800	1676-16A7	See Table 5.31 on page 192
Alarm Enable Flags	91	*	45901-45950	170C-173D	See Table 5.32 on page 192
High Process Limit	80		45351-45400	14E6-1517	See explanation on p. 193
Low Process Limit	83		45501-45550	157C-15AD	
High Deviation Offset	86		45651-45700	1612-1643	
Low Deviation Offset	89		45801-45850	16A8-16D9	
Alarm Deadband	92	0-255	45951-46000	173E-176F	
Alarm Delay	93	0-100	46001-46050	1770-17A1	
High Process Output Destination	81	0-336 3103-4102	45401-45450	1518-1549	
Low Process Output Destination	84	0-336 3103-4102	45551-45600	15AE-15DF	
High Deviation Output Destination	87	0-336 3103-4102	45701-45750	1644-1675	
Low Deviation Output Destination	90	0-336 3103-4102	45851-45900	16DA-170B	

** 16-bit binary number*

NOTE! ***Refer to Setting up Control Channels on page 92 for the basics of setting up closed-loop control channels.***

Process Variable Source (PV Source)

This variable determines the input used as the process variable for this channel. The process variable is a hardware input converted to engineering units. A value of 0 indicates a channel with no input. See *Table 5.13 on page 176* through *Table 5.17 on page 179* for a list and explanation of input numbering.

Table 5.13 Process Variable and Setpoint Source Settings for Analog Inputs on the PPC-202x Modules

Value	Input Name (AnaWin3 Input Spreadsheet)
1	PPC1:AI 1.1
2	PPC1:AI 1.2
⋮	⋮
32	PPC1:AI 1.32
33	PPC1:AI 2.1
34	PPC1:AI 2.2
⋮	⋮
64	PPC1:AI 2.32
65	PPC1:AI 3.1
66	PPC1:AI 3.2
⋮	⋮
96	PPC1:AI 3.32
97	PPC1:AI 4.1
98	PPC1:AI 4.2
⋮	⋮
128	PPC1:AI 4.32

Table 5.14 Process Variable and Setpoint Source Settings for Encoder Inputs on the PPC-2030 Modules

Values	Input Name (AnaWin3 Input Spreadsheet)
129	PPC1:EIAO 11.1.1 C
130	PPC1:EIAO 11.2.1 F
131	PPC1:EIAO 11.1.2 C
132	PPC1:EIAO 11.2.2 F
133	PPC1:EIAO 11.1.3 C
134	PPC1:EIAO 11.2.3 F
135	PPC1:EIAO 11.1.4 C
136	PPC1:EIAO 11.2.4 F
137	PPC1:EIAO 12.1.1 C
138	PPC1:EIAO 12.2.1 F
139	PPC1:EIAO 12.1.2 C
140	PPC1:EIAO 12.2.2 F
141	PPC1:EIAO 12.1.3 C
142	PPC1:EIAO 12.2.3 F
143	PPC1:EIAO 12.1.4 C
144	PPC1:EIAO 12.2.4 F
145	PPC1:EIAO 13.1.1 C
146	PPC1:EIAO 13.2.1 F
147	PPC1:EIAO 13.1.2 C
148	PPC1:EIAO 13.2.2 F
149	PPC1:EIAO 13.1.3 C
150	PPC1:EIAO 13.2.3 F
151	PPC1:EIAO 13.1.4 C
152	PPC1:EIAO 13.2.4 F
153	PPC1:EIAO 14.1.1 C
154	PPC1:EIAO 14.2.1 F
155	PPC1:EIAO 14.1.2 C
156	PPC1:EIAO 14.2.2 F
157	PPC1:EIAO 14.1.3 C
158	PPC1:EIAO 14.2.3 F
159	PPC1:EIAO 14.1.4 C
160	PPC1:EIAO 14.2.4 F

Table 5.15 Process Variable and Setpoint Source Settings for Counter Inputs on the PPC-2010 Module

Value	Input Name (AnaWin3 Input Spreadsheet)
161	PPC1:Proc 0.1.1 C
162	PPC1:Proc 0.2.1 F

Table 5.16 Process Variable and Setpoint Source Settings for Soft Input and Channel Out Registers

Value	Input Name (AnaWin3 Input Spreadsheet)
165	PPC1:Soft Input 1
166	PPC1:Soft Input 2
⋮	⋮
212	PPC1:Soft Input 48
213	Reserved
214	Reserved
215	PPC1:Channel 1 Out
216	PPC1:Channel 2 Out
⋮	⋮
262	PPC1:Channel 48 Out
263	Reserved
264	Reserved

Table 5.17 Process Variable and Setpoint Source Settings for Counter Inputs on the PPC-2040 Modules

Values	Input Name (AnaWin3 Input Spreadsheet)
301	PPC1:DIO 21.1.1 C
302	PPC1:DIO 21.2.1 F
303	PPC1:DIO 21.1.2 C
304	PPC1:DIO 21.2.2 F
305	PPC1:DIO 22.1.1 C
306	PPC1:DIO 22.2.1 F
307	PPC1:DIO 22.1.2 C
308	PPC1:DIO 22.2.2 F
309	PPC1:DIO 23.1.1 C
310	PPC1:DIO 23.2.1 F
311	PPC1:DIO 23.1.2 C
312	PPC1:DIO 23.2.2 F
313	PPC1:DIO 24.1.1 C
314	PPC1:DIO 24.2.1 F
315	PPC1:DIO 24.1.2 C
316	PPC1:DIO 24.2.2 F
317	PPC1:DIO 25.1.1 C
318	PPC1:DIO 25.2.1 F
319	PPC1:DIO 25.1.2 C
320	PPC1:DIO 25.2.2 F
321	PPC1:DIO 26.1.1 C
322	PPC1:DIO 26.2.1 F
323	PPC1:DIO 26.1.2 C
324	PPC1:DIO 26.2.2 F

NOTE! ***The range of values and the precision of the Process Variable and Setpoint depend on the Input Type of the analog input selected as the Process Variable Source for the channel. See Table 5.10 on page 170.***

Process Variable

This register contains the actual value measured by the sensor attached to the input set as the **Process Variable Source** for the channel (see above). The process variable is used in the channel's feedback calculation. This register is read-only.

Setpoint

The setpoint is the desired value for the process variable. The setpoint may be set to any value within the range of the type of the input selected as the **Process Variable Source** for the channel. If the setpoint set is out of the defined range, the controller assigns the closest number within the range.

Control Mode

This parameter indicates the mode of control for the channel. *Table 5.13* lists and describes the values to which this parameter can be set.

Table 5.18 Control Mode

Value	Mode	Description
0	**Off**	Control algorithm is inactive and no output is set.
1	**Manual**	Output is set by the user or a logic program. See *Heat Output* and *Cool Output* in this section.
2	**Auto**	Output is determined by the PID or on/off control algorithm.
3	**Tune**	The PPC determines and sets the proportional band, derivative and integral parameters for the channel by setting the output and measuring the system's response. See *Autotuning on page 93*.

Heat/Cool Feedback Value

The raw output value in parts per thousand (0.1%) calculated by the PID algorithm. In a normal control loops this value is filtered with the output filter before it becomes the **Heat Output** or **Cool Output**.

Heat/Cool Proportional Band (Heat/Cool Prop Band)

The proportional band is used to calculate PID output. Larger numbers result in less proportional action for a given error or deviation from setpoint. This parameter is set in engineering units to a positive value less than the sensor range.

Heat/Cool Integral

The integral term controls the amount of influence the history of error has on the output. Increasing the integral value decreases the integral contribution to the output. Zero is a special case that disables integral action. This value is in seconds per repeat.

Heat/Cool Derivative

The derivative term controls the amount of influence the rate of change of the error has on the output. A greater value yields a greater derivative action. The derivative constant is in units of seconds.

Spread

This is the offset between heat and cool modes when both heat and cool outputs for a channel are used. The spread is also the switching hysteresis for on/off channels. The spread is set in the channel's engineering units to a positive value less than the sensor range.

Heat/Cool Manual Reset

Enter a value to add to the PID output calculation. When the corresponding Integral is set to zero, the value substitutes for the integral sum portion of the feedback calculation. In this case, the output equals the manual reset value when the process variable is at setpoint. When the integral value is set to a value other than zero, the manual reset value is added to the result of the PID calculation and, thereby, shifts the output variable.

This parameter is set in tenths of a percent. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Control Type

Select the function of the channel.

Table 5.19 Control Types

Value	AnaWin3 Name	Description
0	**PID1**	Heat and Cool outputs, only one on at a time.
1	**PID2**	Heat and Cool outputs, both may be on.
3	**Reserved**	n/a
4	**Retransmit**	Retransmit one or two analog inputs

Setpoint Source

This parameter determines how the setpoint for the channel is set. Select **User** for normal closed-loop control applications. Select a channel output (**Channel # Out**) for cascade control. Select an analog input for ratio control, differential control, remote setpoint, or process variable retransmit. A value of 0 indicates a user set setpoint. See *Table 5.13 on page 176* through *Table 5.17 on page 179* for values to select a channel output or analog input as the source of the setpoint value.

Setpoint Ratio

For ratio control, differential control, and remote setpoint applications, set the ratio by which the analog input value selected as the **Setpoint Source** is multiplied to calculate the setpoint. (See *Ratio Control on page 109*, *Differential Control on page 112,* and *Remote Set Point on page 112*.) This parameter may be set to any value from -30000 to 30000 corresponding to a range of -300.00 to 300.00.

Setpoint Offset

For ratio control, differential control, and remote setpoint applications set the offset which is added to the product of the analog input value selected as the **Setpoint Source** and the **Setpoint Ratio** to calculate the setpoint. (*Ratio Control on page 109,Differential Control on page 112,* and *Remote Set Point on page 112*.)

This parameter may be set to any value from -32768 to 32767 The number of decimal places depends on the **Input Type** selected. See *Table 3.15 on page 130*.

Maximum Setpoint

This parameter determines the maximum value the PPC will accept for the setpoint of the channel. This parameter is also used to scale a cascade channel. (See *Cascade Control on page 105).* The range is the same as that of the input type for the channel.

Minimum Setpoint

This parameter determines the minimum value the PPC will accept for the setpoint of the channel. This parameter is also used to scale a cascade channel. *(*See *Cascade Control on page 105).* The range is the same as that of the input type for the channel.

Heat/Cool Output Type

This parameter specifies the type of output signal and determines whether the PID or on/off control algorithm is used for the channel. See *Table 5.20 on page 183*. For specific information on control terminology and definitions, refer to *Chapter 6, Control Terminology*.

Table 5.20 Output Types

Value	AnaWin3 Name	Description	Destinations
0	**Time Prop**	Digital, time proportioned	Digital output from a PPC-2010, PPC-2040 or PPC-206x, Soft Bool internal database value.
1	**DZC**	Digital, distributed zero crossing	Digital output from a PPC-2010 or PPC-2040
2	**On/Off**	Digital, on/off	Digital output from a PPC-2010, PPC-2040, or PPC-206x, Soft Bool internal database value.
3-14	**Reserved**		
15	**Internal Count**	Internal analog software (register)	Soft Int internal database value.Stored in the database in the PPC-2010. No additional hardware required. Cannot drive field I/O device directly.
16	**Analog 0-20mA**	Analog output type, 0-20mA	Analog output using a PPC-2030 or PPC-2050 Soft Int internal database value.
17	**Analog 4-20mA**	Analog output type, 4-20mA	
18	**Analog 0-5Vdc**	Analog output type, 0-5Vdc	
19	**Analog 1-5Vdc**	Analog output type, 1-5Vdc	
20	**Analog 0-10Vdc**	Analog output type, 0-10Vdc	
21	**SDAC 0-20mA**	Serial digital-to-analog converter, 0-20mA	Analog output using a digital output from the PPC-2010 module connected to a peripheral SDAC module.
22	**SDAC 4-20mA**	Serial digital-to-analog converter, 4-20mA	
23	**SDAC 0-5Vdc**	Serial digital-to-analog converter, 0-5Vdc	
24	**SDAC 1-5Vdc**	Serial digital-to-analog converter, 1-5Vdc	
25	**SDAC 0-10Vdc**	Serial digital-to-analog converter, 0-10Vdc	

Heat/Cool Cycle Time

Specify the time base in seconds for time proportional outputs. The output percentage is proportioned over this time period. For example, a 50% output with a 10-second cycle time is on for 5 seconds and off for 5 seconds. Output cycle time only affects control when the corresponding output type is set to **Digital Time Proportioning (Time Prop)**.

Heat/Cool Scale Lo

A control output may be linearly scaled by setting this parameter. Set the percent of the output range of the selected **Heat/Cool Output Type** that should correspond to a calculated **Heat/Cool Output%** of 0%.

This parameter is set in tenths of a percent. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Heat/Cool Scale Hi

A control output may be linearly scaled by setting this parameter. Set the percent of the output range of the selected **Heat/Cool Output Type** that should correspond to a calculated **Heat/Cool Output%** of 100%.

This parameter is set in tenths of a percent. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Heat/Cool Curve

Use this register to choose which output scaling method is used. Straight linear is used for most applications. Lag curves are usually used in plastic extruder applications. *Table 5.21 on page 184* lists and describes the values to which this parameter may be set. *Figure 5.2 on page 185* illustrates the effects of the options.

Table 5.21 Heat/Cool Curve

Value	AnaWin3 Name	Description
0	**Straight linear**	Output is unaffected and is set as calculated by the closed-loop PID calculation.
1	**Lag curve A**	Output is reduced somewhat from calculated value.
2	**Lag curve B**	Output is further reduced from calculated value.

Heat/Cool Scale Lo
Set this parameter in conjunction with **Heat/Cool Scale Hi** to scale the output or to change the control action. (See table 3.x.) Enter the value, as a percent of range, that the output should approach as the process variable approaches the set point from below for a heat output or from above for a cool output. See Figure 3.x.

The default and typical value is 0%. For example, as a heater raises the temperature of a load towards set point, the output decreases toward 0%. In some cases it is desirable that the output never reach 0%, in that case enter a minimum value greater than 0%.

This parameter is set in tenths of a percent. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Heat/Cool Scale Hi
Set this parameter in conjunction with **Heat/Cool Scale Lo** to scale the output or to change the control action. (See table 3.x.) Enter the value, as a percent of range, that the output should approach as the process variable moves away from the set point either upward for a heat output or downward for a cool output. See Figure 3.x.

The default and typical value is 100%. For example, as the temperature of a heated system drops the controller increases its output toward 100%. In some cases it is desirable that the output never reach 100%, in that case enter a maximum value less than 100%. See also **Auto Heat/Cool Limit**.

This parameter is set in tenths of a percent. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

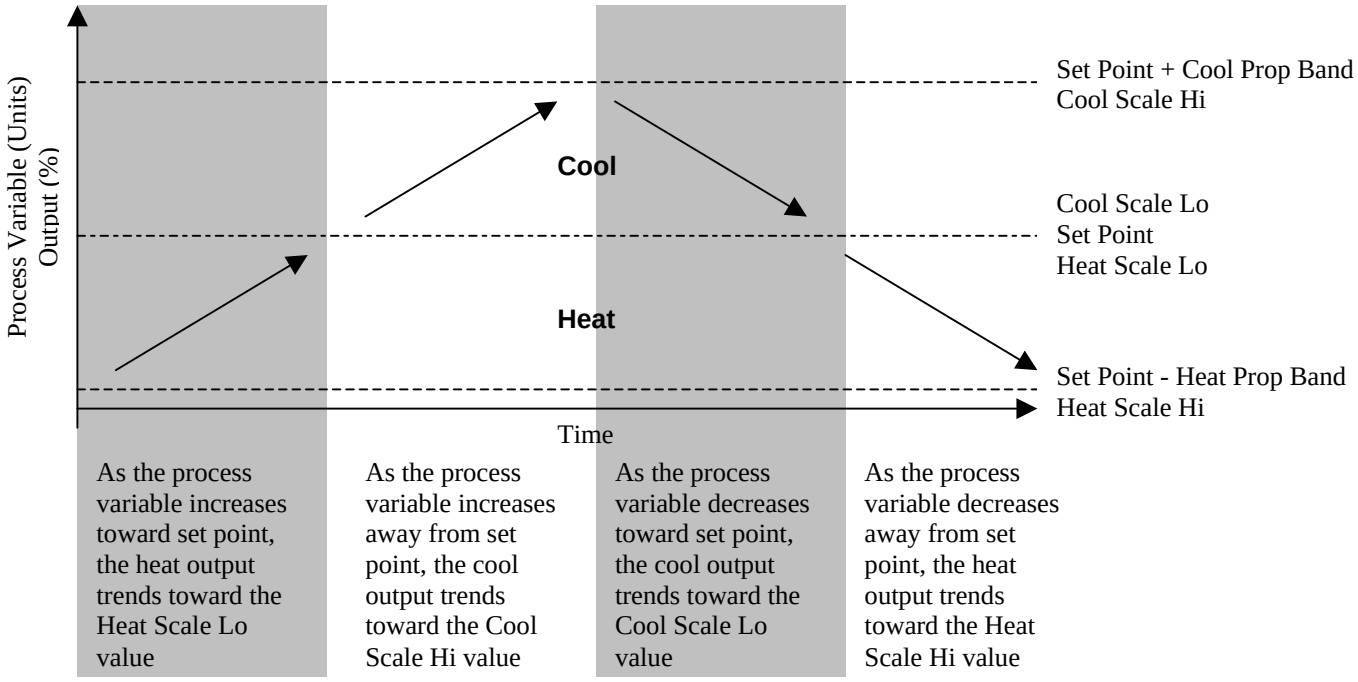
Note
Sometimes it is necessary for a heat output to *increase* as the process variable approaches the set point from below. In such cases the **Heat/Cool Scale Lo** value is set above the **Heat/Cool Scale Hi** parameter. (See Direct Heat in Table 3.x.) For example, in some systems heat is added outside the control loop and the heat output controls a cooling water flow. In such a system as the temperature rises to set point, the output increases to flow more water and slow the heating process.

Table 3.x Output Scaling Parameters Settings and Control Action

Output	Control Action	Scale Lo	Scale Hi	Note
Heat	Reverse (Default)	0%	100%	As the process variable increases, the output decreases.
Cool	Reverse	100%	0%	
Heat	Direct	100%	0%	As the process variable increases, the output increases.
Cool	Direct (Default)	0%	100%	

CAUTION
When a **Heat/Cool Scale Lo** parameter is set to a value *greater* than the corresponding **Heat/Cool Scale Hi**, the **Heat Output %** or **Cool Output %** values are inversely related to the actual output signal. In this case when the **Heat/Cool Output %** indicates 0% the output is *fully on* regardless of whether the **Control Mode** is set to Auto, Manual or Tune. Always remove power from the controller before servicing any components.

Figure 3.x Heat and Cool Scaling Parameters


Process Variable (Units)
Output (%)
Set Point + Cool Prop Band
Cool Scale Hi
Cool
Cool Scale Lo
Set Point
Heat Scale Lo
Heat
Set Point - Heat Prop Band
Heat Scale Hi
Time
As the process variable increases toward set point, the heat output trends toward the Heat Scale Lo value
As the process variable increases away from set point, the cool output trends toward the Cool Scale Hi value
As the process variable decreases toward set point, the cool output trends toward the Cool Scale Lo value
As the process variable decreases away from set point, the heat output trends toward the Heat Scale Hi value

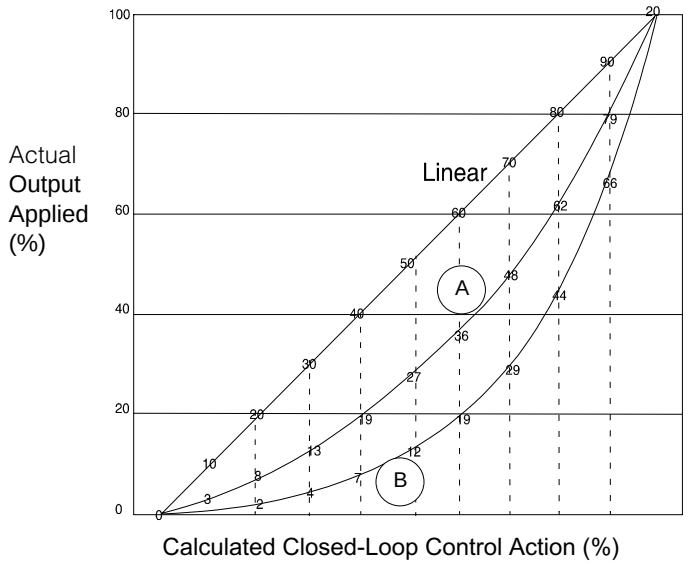


Figure 5.2 Output Scaling Curves

Auto Heat/Cool Limit

This parameter limits the control output for a channel's heat and cool outputs. This limit may be continuous, or it may be in effect for a specified number of seconds (see **Heat/Cool Limit Time** below). If you choose a timed limit, the output limit restarts when the controller powers up and when the channel changes from **Manual** to **Automatic** control. The output limit only affects channels under automatic control. It does not affect channels under manual control. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Heat/Cool Limit Time

Set a time limit for the **Auto Heat/Cool Limit**. If set to 0, the limit is in effect whenever the channel is in automatic control. The Heat/Cool **Limit Time** is set in seconds.

Sensor Fail Heat/Cool%

When a failed sensor alarm occurs on a channel under automatic control, that channel goes to **Manual** control at this percent power output. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Heat/Cool Output Filter

This parameter determines how much the heat or cool output's response is damped. The **Heat** or **Cool Output** responds to a step change in **Feedback Value** by going to approximately 2/3 of its final value within the number of scans set. A larger number yields a slower, or more damped, control response to changes in the calculated output. A value of 0 disables the filter.

Heat/Cool Output%

Set a heat or cool output value in percent when the channel is in **Manual** control mode, or monitor the output in **Automatic** control. For PID output types, the output is calculated based on the heat PID parameters. The valid range is 0 to 1000 and corresponds to 0.0% to 100.0%: for example, a setting of 500 corresponds to 50.0%.

Heat/Cool Output Destination (Heat/Cool Output Dest)

Select the output destination to specify the I/O point used for the control output. This is the output for the closed-loop control channel. Selecting 0 indicates no output is to be used, and is an appropriate setting for monitor-only channels. Values are calculated for the corresponding output whenever the output destination has a non-zero setting. If both the heat and cool output destinations are non-zero, the channel performs bimodal control. See *Heat and Cool Outputs on page 90.* Refer to *Table 5.22* for a list of values and the corresponding physical or software output destinations.

Table 5.22 Output Destinations for Digital Outputs on the PPC-2010 Module

Value	Digital I/O Name (AnaWin3 Dig I/O Spreadsheet)
1	PPC1:Proc 0.0.1
2	PPC1:Proc 0.0.2
⋮	⋮
48	PPC1:Proc 0.0.48

Table 5.23 Output Destinations for Digital Outputs on the PPC-2040 Modules

Value	Digital I/O Name (AnaWin3 Dig I/O Spreadsheet)
49	PPC1:DIO 21.0.1
50	PPC1:DIO 21.0.2
⋮	⋮
80	PPC1:DIO 21.0.32
81	PPC1:DIO 22.0.1
82	PPC1:DIO 22.0.2
⋮	⋮
112	PPC1:DIO 22.0.32
113	PPC1:DIO 23.0.1
114	PPC1:DIO 23.0.2
⋮	⋮
144	PPC1:DIO 23.0.32
145	PPC1:DIO 24.0.1
146	PPC1:DIO 24.0.2
⋮	⋮
176	PPC1:DIO 24.0.32
177	PPC1:DIO 25.0.1
178	PPC1:DIO 25.0.2
⋮	⋮
208	PPC1:DIO 25.0.32
209	PPC1:DIO 26.0.1
210	PPC1:DIO 26.0.2
⋮	⋮
240	PPC1:DIO 26.0.32

Table 5.24 Output Destinations for Digital Outputs on the PPC-206x Modules

Value	Digital I/O Name (AnaWin3 Dig I/O Spreadsheet)
241	PPC1:DO 41.1
242	PPC1:DO 41.2
⋮	⋮
256	PPC1:DO 41.16
257	PPC1:DO 42.1
258	PPC1:DO 42.2
⋮	⋮
272	PPC1:DO 42.16
273	PPC1:DO 43.1
274	PPC1:DO 43.2
⋮	⋮
288	PPC1:DO 43.16
289	PPC1:DO 44.1
290	PPC1:DO 44.2
⋮	⋮
304	PPC1:DO 44.16
305	PPC1:DO 45.1
306	PPC1:DO 45.2
⋮	⋮
320	PPC1:DO 45.16
321	PPC1:DO 46.1
322	PPC1:DO 46.2
⋮	⋮
336	PPC1:DO 46.16

Table 5.25 Output Destinations for Analog Outputs on the PPC-2030 Modules

Value	Output Name (AnaWin3 Outputs Spreadsheet)
1001	PPC1:EIAO 11.3.1
1002	PPC1:EIAO 11.3.2
1003	PPC1:EIAO 11.3.3
1004	PPC1:EIAO 11.3.4
1005	PPC1:EIAO 12.3.1
1006	PPC1:EIAO 12.3.2
1007	PPC1:EIAO 12.3.3
1008	PPC1:EIAO 12.3.4
1009	PPC1:EIAO 13.3.1
1010	PPC1:EIAO 13.3.2
1011	PPC1:EIAO 13.3.3
1012	PPC1:EIAO 13.3.4
1013	PPC1:EIAO 14.3.1
1014	PPC1:EIAO 14.3.2
1015	PPC1:EIAO 14.3.3
1016	PPC1:EIAO 14.3.4

Table 5.26 Output Destinations for Analog Outputs on the PPC-205x Modules

Value	Output Name (AnaWin3 Outputs Spreadsheet)
1017	PPC1:AO 31.1
1018	PPC1:AO 31.2
⋮	⋮
1024	PPC1:AO 31.8
1025	PPC1:AO 32.1
1026	PPC1:AO 32.2
⋮	⋮
1032	PPC1:AO 32.8
1033	PPC1:AO 33.1
1034	PPC1:AO 33.2
⋮	⋮
1040	PPC1:AO 33.8
1041	PPC1:AO 34.1
1042	PPC1:AO 34.2
⋮	⋮
1048	PPC1:AO 34.8

Table 5.27 Output Destinations for Soft Boolean and Soft Integers

Value	AnaWin3 Name (Soft Bool and Soft Int[1] Spreadsheets)
3001	PPC1:Soft Bool 1
3002	PPC1:Soft Bool 2
⋮	⋮
4000	PPC1:Soft Bool 1000
2051	PPC1:Soft Int 1
2052	PPC1:Soft Int 2
⋮	⋮
2150	PPC1:Soft Int 100

[1]Soft Integers 1-100 may be used as output destinations. Extended Soft Integers 101-2100 may not be used as output destinations.

NOTE! ***See Alarms on page 95 for an overview of alarm functions.***

Alarm Status Flags

Each **Alarm Status** register contains a 16-bit word. The bits may be read to detect the status of each of a channel's alarms. When an alarm occurs, the controller sets the appropriate bit equal to one. When the alarm condition clears, the controller sets the bit back to 0. *Table 5.28* summarizes these definitions. See *Table 5.29 on page 191* for alarm bit definitions.

Table 5.28 Alarm Status

Value	Condition
0	No alarm condition exists
1	Alarm condition exists

Table 5.29 Alarm Bit Definitions

Bit	Alarm Name
1 (least significant)	Spare
2	Spare
3	Low deviation
4	High deviation
5	Low process
6	High process
7	Spare
8	Spare
9	T/C break (or open)
10	RTD open
11	RTD short
12	Spare
13	Spare
14	Ambient Temperature
15	Spare
16 (most significant)	Spare

CAUTION! ***Failed sensor alarms are only checked on inputs associated with channels. Any input that is not selected as the* PV Source *of a channel will not generate failed sensor alarms.***

Alarm Control Flags

Each **Alarm Control** register contains a 16-bit word. The bits determine the behavior of the various alarms. Setting an **Alarm Control** bit to 1 makes the corresponding alarm behave as a control. Setting a bit to 0 makes it behave as a standard alarm. *Table 5.30 on page 192* describes the difference between standard alarms and controls. See *Table 5.29* for alarm bit definitions.

Table 5.30 Alarm and Control Functionality

Value	Function	Description
0	Alarm	Standard alarm function. Digital output, if set, activates on alarm, deactivates when channel is not in alarm. Global alarm output activates and requires alarm acknowledgment to clear.
1	Control	Digital output, if set, activates on alarm, deactivates when channel is not in alarm. Global alarm output does not activate. No alarm acknowledgment required to clear.

Alarm Acknowledge Flags

Each **Alarm Acknowledge** register contains a 16-bit word. When an alarm occurs and it is not a control alarm, the corresponding **Alarm Acknowledge** bit is set equal to 1. The bit remains set even if the corresponding alarm condition is corrected. Read the **Alarm Acknowledge** bits to determine if there are unacknowledged alarms. Set bits to 0 to acknowledge the corresponding alarm.

Table 5.31 Alarm Acknowledge

Value	Description
0	Acknowledged alarm
1	Unacknowledged alarm

Alarm Enable Flags

Alarm Status and **Alarm Acknowledge** bits are set when the process variable crosses the process or deviation limit only when the corresponding alarm enable bit set to 1. Set the alarm enable bit to 1 for each alarm limit to be monitored. Set the alarm enable bit to 0 to ignore the corresponding alarm.

Table 5.32 Alarm Enable/Disable

Value	Description
0	Disable
1	Enable

NOTE! ***The range and precision of the process limits and deviation offsets are the same as that of the corresponding input. See Table 5.10 on page 170.***

High Process Limit (HP Limit)

The high process alarm activates when the **Process Variable** (PV) goes above the high process setpoint. The PV must drop to the alarm setpoint minus the alarm deadband for the alarm to clear. The alarm limit is set in the engineering units of the channel. Its value does not change when the process setpoint changes. The default high process alarm setpoint is 0.

Low Process Limit (LP Limit)

The low process alarm activates when the process variable (PV) goes below the low process setpoint. The PV must rise to the alarm setpoint plus the alarm deadband for the alarm to clear. The alarm limit is set in the engineering units of the channel. Its value does not change when the process setpoint changes. The default low process alarm setpoint is 0.

High Deviation Offset (HD Offset)

This value determines the high deviation alarm limit relative to the current setpoint. The high deviation alarm occurs when the process variable is greater than the current setpoint plus this value. The offset is set in the engineering units of the channel but relative to the process setpoint. The alarm limit changes when the process setpoint changes. The default high deviation offset is 0.

Low Deviation Offset (LD Offset)

This value determines the low deviation alarm limit relative to the current setpoint. The low deviation alarm occurs when the process variable is lower than the current setpoint less this value. The offset is set in the engineering units of the channel but relative to the process setpoint. The alarm limit changes when the process setpoint changes. The default low deviation offset is 0.

Alarm Deadband

This parameter prevents the process and deviation alarms from toggling on and off when the process variable is near the alarm limit. For high alarms the deadband is below the setpoint; for low alarms the deadband is above the setpoint. An alarm that occurs when the process variable crosses the alarm setpoint does not clear until the process returns within the alarm setpoint and the deadband value. The deadband is set in the engineering units of the channel. The default alarm deadband is 2.

Alarm Delay

This value delays alarm reporting, to prevent the reporting of false alarms due to noise on the input. The alarm delay applies to failed sensor alarms and process and deviation alarms. Only alarms that are present for longer than the alarm delay time are reported. The alarm delay is set in seconds.

NOTE!

Use the Database Offset number of an output for the alarm output value. See Table 5.33 on page 196 through Table 5.36 on page 199.

If more than one alarm is assigned to the same output number, that output will be on if any of those alarms is active.

High Process Output Destination (HP Output Dest)

Choose the digital output that is toggled when the high process alarm occurs. This can be any available hardware output or a Boolean register accessible to the logic program. The default high process alarm output is 0. When 0 is selected there is no output.

Low Process Output Destination (LP Output Dest)

Choose the digital output that is toggled when the low process alarm occurs. This may be any available hardware output a Boolean register accessible to the logic program. The default alarm output is 0. When 0 is selected there is no output.

High Deviation Output Destination (HD Output Dest)

Choose the digital output that is toggled when the high deviation alarm occurs. This may be any available hardware output or a Boolean register accessible to the logic program. The default alarm output is 0. When 0 is selected there is no output.

Low Deviation Output Destination (LD Output Dest)

Choose the digital output that is toggled when the low deviation alarm occurs. This may be any available hardware output or a Boolean register accessible to the logic program. The default alarm output is 0. When 0 is selected there is no output.

Digital I/O Parameters in the Database

Digital I/O parameters determine the state and behavior of digital inputs and outputs found on the PPC's Processor, Digital I/O, Digital Input and Digital Output modules.

State and Logic

The **State** registers containing the value of the digital I/O point must be interpreted in terms of the **Logic**, in order to determine the physical state of the I/O point.

For example, if the **State** is 1 and the **Logic** is 1=On, the corresponding input or output is on. For a dc digital input this indicates the input is connected to the power supply common. For an ac input this indicates the signal is detected. For a digital output or relay output this indicates the output is conducting.

Conversely, if the **State** is 1 and the **Logic** is 0=On, the corresponding input or output is off. For an input, this indicates the field device is an open circuit. For an open collector output, this indicates the output is an open circuit. For a relay output, this indicates the output is de-energized.

Accessing Digital I/O Parameters with Modbus

For Digital I/O parameters, the Modbus address offsets correspond to the digital I/O numbers. See *Table 5.33 on page 196 through Table 5.36 on page 199* for a list of the module I/O numbers corresponding to the digital I/O on the Processor and Digital I/O modules.

Addresses for digital I/O **State**, **Direction**, **Logic** are relative to the hardware connection to the corresponding field I/O device. For example, the PPC-2000 processor module has 48 digital I/O points with registered addresses 1 to 48. The state of the device connect to pin 1 on the TB50 is stored at address 03001. The state of the device connected to pin 2 on the TB50 is stored at address 03002, and so on.

Table 5.38 on page 200 lists first and last Modbus addresses for each digital I/O parameter. Use these addresses when accessing digital I/O parameters with third-party software or operator interface terminals.

Accessing Digital I/O Parameters with *LogicPro*

When a logic program variable accesses a digital input **State**, the *LogicPro* IO Physical Address is used in conjunction with the *LogicPro* IO Driver for the corresponding module type. See *Table 5.33 on page 196* to determine the *LogicPro* IO Physical Address.

The *LogicPro* IO Physical Addresses are listed by I/O point according to the default names as seen in AnaWin3. To correlate the AnaWin3 name with the hardware connection see *Table 2.10 on page 39*, *Table 2.23 on page 72*, and *Table 2.24 on page 76*. When a logic program variable accesses a digital I/O parameter, the parameter number (#) and the Database Offset are used in conjunction with the *LogicPro's* Database IO Driver. The IO Physical Address is constructed from the parameter number and the database offset.

See the *LogicPro User's Guide* for specific instructions on addressing digital I/O parameters. See *Table 5.33 on page 196* for a list of the database offsets for each digital I/O point. See *Table 5.38 on page 200* for digital I/O parameter numbers.

Digital I/O Numbers and Address Offsets

Table 5.33 lists the *LogicPro* IO Physical Address, Database Offsets and sample Modbus address corresponding to each digital I/O point.

Table 5.33 Database Offsets and Sample Modbus Addresses for Digital I/O

AnaWin3 Name[1] (Dig I/O Spreadsheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Processor_2010 IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:Proc 0.0.1	0.0.1	#.1	1	00001
PPC1:Proc 0.0.2	0.0.2	#.2	2	00002
⋮	⋮	⋮	⋮	⋮
PPC1:Proc 0.0.48	0.0.48	#.48	48	00048

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Digital I/O on page 132* for a full explanation of digital I/O naming.

[2]LogicPro Variable Type must be BOOL.

[3]Use this address with the *Processor_2010 IO Driver* when addressing **State**.

[4]Use this address with the *Database IO Driver* when addressing input parameters other than **State**. Replace the # with the parameter number (#) from *Table 5.38 on page 200* for the parameter you want to address.

Table 5.34 Addresses for Digital I/O on the PPC-2040 Digital I/O Modules

AnaWin3 Name[1] (Dig I/O Spread-sheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Digital_IO_2040 IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:DIO 21.0.1	21.0.1	#.49	49	00049
PPC1:DIO 21.0.2	21.0.2	#.50	50	00050
⋮	⋮	⋮	⋮	⋮
PPC1:DIO 21.0.32	21.0.32	#.80	80	00080
PPC1:DIO 22.0.1	22.0.1	#.81	81	00081
PPC1:DIO 22.0.2	22.0.2	#.82	82	00082
⋮	⋮	⋮	⋮	⋮
PPC1:DIO 22.0.32	22.0.32	#.112	112	00112
PPC1:DIO 23.0.1	23.0.1	#.113	113	00113
PPC1:DIO 23.0.2	23.0.2	#.114	114	00114
⋮	⋮	⋮	⋮	⋮
PPC1:DIO 23.0.32	23.0.32	#.144	144	00144
PPC1:DIO 24.0.1	24.0.1	#.145	145	00145
PPC1:DIO 24.0.2	24.0.2	#.146	146	00146
⋮	⋮	⋮	⋮	⋮
PPC1:DIO 24.0.32	24.0.32	#176	176	00176
PPC1:DIO 25.0.1	25.0.1	#.177	177	00177
PPC1:DIO 25.0.2	25.0.2	#.178	178	00178
⋮	⋮	⋮	⋮	⋮
PPC1:DIO 25.0.32	25.0.32	#.208	208	00208
PPC1:DIO 26.0.1	26.0.1	#.209	209	00209
PPC1:DIO 26.0.2	26.0.2	#.210	210	00210
⋮	⋮	⋮	⋮	⋮
PPC1:DIO 26.0.32	26.0.32	#.240	240	00240

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Digital I/O on page 132* for a full explanation of digital I/O naming.

[2]LogicPro Variable Type must be BOOL.

[3]Use this address with the *Digital_IO_2040 IO Driver* when addressing **State**.

[4]Use this address with the *Database IO Driver* when addressing digital I/O parameters other than **State**. Replace the # with the parameter number (#) from *Table 5.38 on page 200* for the parameter you want to address.

Table 5.35 Addresses for Digital Outputs on the PPC-206x Digital Out Modules

AnaWin3 Name[1] (Dig I/O Spread-sheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Digital_Out_206x IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:DO 41.1	41.1	#.241	241	00241
PPC1:DO 41.2	41.2	#.242	242	00242
⋮	⋮	⋮	⋮	⋮
PPC1:DO 41.16	41.16	#.256	256	00256
PPC1:DO 42.1	42.1	#.257	257	00257
PPC1:DO 42.2	42.2	#.258	258	00258
⋮	⋮	⋮	⋮	⋮
PPC1:DO 42.16	42.16	#.272	272	00272
PPC1:DO 43.1	43.1	#.273	273	00273
PPC1:DO 43.2	43.2	#.274	274	00274
⋮	⋮	⋮	⋮	⋮
PPC1:DO 43.16	43.16	#.288	288	00288
PPC1:DO 44.1	44.1	#.289	289	00289
PPC1:DO 44.2	44.2	#.290	290	00290
⋮	⋮	⋮	⋮	⋮
PPC1:DO 44.16	44.16	#.304	304	00304
PPC1:DO 45.1	45.1	#.305	305	00305
PPC1:DO 45.2	45.2	#.306	306	00306
⋮	⋮	⋮	⋮	⋮
PPC1:DO 45.16	45.16	#.320	320	00320
PPC1:DO 46.1	46.1	#.321	321	00321
PPC1:DO 46.2	46.2	#.322	322	00322
⋮	⋮	⋮	⋮	⋮
PPC1:DO 46.16	46.16	#.336	336	00336

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Digital I/O on page 132* for a full explanation of digital I/O naming.

[2]LogicPro Variable Type must be BOOL.

[3]Use this address with the *Digital_Out_206x IO Driver* when addressing **State**.

[4]Use this address with the *Database IO Driver* when addressing digital I/O parameters other than **State**. Replace the # with the parameter number (#) from *Table 5.38 on page 200* for the parameter you want to address.

Table 5.36 Addresses for Digital Inputs on the PPC-207x Digital In Modules

AnaWin3 Name[1] (Dig I/O Spread-sheet)	LogicPro I/O Physical Address[2]		Modbus Addressing	
	Digital_In_207x IO Driver[3]	Database IO Driver[4]	Database Offset	Sample Address
PPC1:DI 51.1	51.1	#.337	337	00337
PPC1:DI 51.2	51.2	#.338	338	00338
⋮	⋮	⋮	⋮	⋮
PPC1:DI 51.16	51.16	#.352	352	00352
PPC1:DI 52.1	52.1	#.353	353	00353
PPC1:DI 52.2	52.2	#.354	354	00354
⋮	⋮	⋮	⋮	⋮
PPC1:DI 52.16	52.16	#.368	368	00368
PPC1:DI 53.1	53.1	#.369	369	00369
PPC1:DI 53.2	53.2	#.370	370	00370
⋮	⋮	⋮	⋮	⋮
PPC1:DI 53.16	53.16	#.384	384	00384
PPC1:DI 54.1	54.1	#.385	385	00385
PPC1:DI 54.2	54.2	#.386	386	00386
⋮	⋮	⋮	⋮	⋮
PPC1:DI 54.16	54.16	#.400	400	00400

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Digital I/O on page 132* for a full explanation of digital I/O naming.

[2]LogicPro Variable Type must be BOOL.

[3]Use this address with the *Digital_In_207x IO Driver* when addressing **State**.

[4]Use this address with the *Database IO Driver* when addressing digital I/O parameters other than **State**. Replace the # with the parameter number (#) from *Table 5.38 on page 200* for the parameter you want to address.

Digital I/O Uses

The Processor module and the Digital I/O modules have 48 I/O points each. These modules have configurable I/O. Some or all of their points can be individually configured as either an input or an output by setting a bit in the *Direction* register.

24 of the 48 I/O points on the Processor module are configurable. 22 I/O points are fixed as outputs. The remaining two I/O points are reserved for the global alarm and CPU fail/system OK signals.

Some I/O points can be used for frequency or counter inputs or serial digital-to-analog (SDAC) outputs.

Refer to *Table 5.37 on page 200* for specific information.

Table 5.37 Digital I/O Uses

Use	PPC-2010	PPC-2040	PPC-2061	PPC-2062	PPC-2070 PPC-2072	PPC-2071 PPC-2073
Configurable I/O points	1-24	1-32	n/a	n/a	n/a	n/a
Output only points	25-46	n/a	1-16	1-8	n/a	n/a
Input only points	n/a	n/a	n/a	n/a	1-8	1-16
Pulse or counter inputs	1	1-2	n/a	n/a	n/a	n/a
Digital outputs that may be used as SDACs	41-45	n/a	n/a	n/a	n/a	n/a
Reserved outputs (Global Alarm, CPU Watchdog)	47, 48	n/a	n/a	n/a	n/a	n/a
SDAC clock output	46	n/a	n/a	n/a	n/a	n/a

Digital I/O Parameters

Table 5.38 lists the parameter number (#), range, and first and last Modbus addresses for each digital I/O parameter. These values are used when accessing digital I/O parameters with third-party software, operator interface terminals or *LogicPro* programs.

All the digital I/O parameters are 1 bit values and, therefore, have a range of 0-1. See the tables under the corresponding parameter descriptions for explanations of the possible settings.

Table 5.38 Digital I/O Parameters

Parameter	#	Range	Modbus Address	Hex Address
State	130	0-1	00001-03560	0-DE7
Direction	132	0-1	01001-02000	3E8-7CF
Logic	133	0-1	02001-03000	7D0-BB7

State

This register stores a logical bit which together with the corresponding **Logic** bit determines the physical state of digital outputs and indicates the state of digital inputs. When writing to these bits, the controller will ignore any data being written to an I/O point configured as an input. *Table 5.39 on page 201* lists and describes possible combinations of **State** and **Logic** values.

Table 5.39 State and Logic

State Value	Logic Value	Description
0	0(1=On)	Input signal detected or output is energized
0	1(0=On)	Input signal not detected or output is de-energized
1	0(1=On)	Input signal detected or output is energized
1	1(0=On)	Input signal not detected or output is de-energized

Direction

Select whether the flexible I/O points are being used as inputs or outputs. All flexible I/O points default to inputs. See *Table 5.37 on page 200* for restrictions on particular I/O points.

Table 5.40 Direction

Value	State
0	**Input**
1	**Output**

Logic

Specify the active, true level (On state) for each system digital output.

Table 5.41 Logic

Value	State
0	**1=On**
1	**0=On**

Analog Output Parameters in the Database

Analog Output Value is the only analog output parameter. The analog output registers determine the levels of signals output by the analog outputs on the Encoder In Analog Out modules.

Accessing Analog Outputs with Modbus

The Modbus address offsets for **Analog Output Value** correspond to the analog output. See *Table 5.42 on page 203* and *Table 5.43 on page 204* for a list of the analog outputs and the corresponding Modbus addresses.

The table lists first and last Modbus addresses for each module with analog outputs. Use these addresses when accessing analog output values with third-party software or operator interface terminals.

Accessing Analog Outputs with *LogicPro*

When a logic program variable accesses an **Analog Output Value**, the *LogicPro* IO Physical Address is used in conjunction with the *LogicPro* IO driver for the corresponding module type.

The *LogicPro* IO Physical Addresses are listed by output according to the default output names as seen in AnaWin3. To correlate the AnaWin3 name with the hardware connection see *Table 2.20 on page 60 and Table 2.22 on page 67*.

See the *LogicPro User's Guide* for specific instructions on addressing analog outputs. See *Table 5.42* and *Table 5.43* for a list of the *LogicPro* IO Physical Addresses corresponding to the analog outputs.

Analog Outputs and Modbus Addresses

Table 5.42 and *Table 5.43* list the *LogicPro* I/O physical address and Modbus address for each **Analog Output Value** corresponding to the modules, module addresses and module output numbers of each analog output.

Table 5.42 Addresses for Analog Outputs on the PPC-2030 Encoder In Analog Out Modules

AnaWin3 Name[1] (Output Spreadsheet)	LogicPro I/O Physical Address	Modbus Addressing	
	Encoder_Analog_2030 IO Driver[2]	Decimal	Hex
PPC1:EIAO 11.3.1	11.3.1	46201	1838
PPC1:EIAO 11.3.2	11.3.2	46202	1839
PPC1:EIAO 11.3.3	11.3.3	46203	183A
PPC1:EIAO 11.3.4	11.3.4	46204	183B
PPC1:EIAO 12.3.1	12.3.1	46205	183C
PPC1:EIAO 12.3.2	12.3.2	46206	183D
PPC1:EIAO 12.3.3	12.3.3	46207	183E
PPC1:EIAO 12.3.4	12.3.4	46208	183F
PPC1:EIAO 13.3.1	13.3.1	46209	1840
PPC1:EIAO 13.3.2	13.3.2	46210	1841
PPC1:EIAO 13.3.3	13.3.3	46211	1842
PPC1:EIAO 13.3.4	13.3.4	46212	1843
PPC1:EIAO 14.3.1	14.3.1	46213	1844
PPC1:EIAO 14.3.2	14.3.2	46214	1845
PPC1:EIAO 14.3.3	14.3.3	46215	1846
PPC1:EIAO 14.3.4	14.3.4	46216	1847

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Outputs on page 135* for a full explanation of analog output naming.

[2]Use this address with the *Encoder_Analog_2030 IO Driver* when addressing **Analog Output Value**. There are no other analog output parameters so you will not use the *Database IO Driver*.

Table 5.43 Addresses for Analog Outputs on the PPC-205x Analog Out Modules

AnaWin3 Name[1] (Output Spreadsheet)	LogicPro I/O Physical Address	Modbus Addressing	
	Analog_Out_205x IO Driver[2]	Decimal	Hex
PPC1:AO 31.1	31.1	46267	187A
PPC1:AO 31.2	31.2	46268	187B
⋮	⋮	⋮	⋮
PPC1:AO 31.8	31.8	46274	1881
PPC1:AO 32.1	32.1	46275	1882
PPC1:AO 32.2	32.2	46276	1883
⋮	⋮	⋮	⋮
PPC1:AO 32.8	32.8	46282	1889
PPC1:AO 33.1	33.1	46283	188A
PPC1:AO 33.2	33.2	46284	188B
⋮	⋮	⋮	⋮
PPC1:AO 33.8	33.8	46290	1891
PPC1:AO 34.1	34.1	46291	1892
PPC1:AO 34.2	34.2	46292	1893
⋮	⋮	⋮	⋮
PPC1:AO 34.8	34.8	46298	1899

[1]The AnaWin3 names are shown for the first PPC-2000 in the system. See *Outputs on page 135* for a full explanation of analog output naming.

[2]Use this address with the *Analog_Out_205x IO Driver* when addressing **Analog Output Value**. There are no other analog output parameters so you will not use the *Database IO Driver*.

Analog Output Value

An array of addressable I/O words that represent the output value for each analog output as a number between 0 and 32767. These numbers correspond to the minimum and maximum output signal levels for the selected **Output Type**. The analog signal range is determined by the hardware, jumper configuration, and the setting of the **Output Type** for the channel with the output selected as **Heat/Cool Output Destination**.

Range: **0** to **32767**

NOTE! ***The resolution of the analog outputs is 12 bit. The output Value is displayed as a 15-bit integer. The output Value must change by more than seven to effect a measurable change in an analog output.***

Soft Bool and Soft Int Registers in the Database

The database provides 1000 1-bit (Boolean) registers and 2100 word (Integer) registers that may be accessed both by a logic program and by *AnaWin3* or third-party software.

Table 5.44 lists the parameter number, range, and first and last Modbus addresses for each Soft Bool and Soft Int parameter.

Table 5.44 Soft Bool and Soft Int Parameters

Parameter	#	Range	Modbus Address	Hex Address
Soft Bool	134	0-1	3001-4000	BB8-F9F
Soft Int	136	-32,768 to 32,767	46301-46400	189C-18FF
Extended Soft Int	137	-32,768 to 32,767	47001-49000	1B58-2327

Accessing Soft Bool and Soft Int Registers with Modbus

The Boolean and Integer registers are accessed by Modbus address. *Table 5.46 on page 206* lists first and last Modbus addresses for the Boolean and Integer registers. Use these addresses when accessing Boolean and Integer registers with third-party software or operator interface terminals.

Accessing Soft Bool and Soft Int Registers with *LogicPro*

When a logic program variable accesses a Boolean or Integer register, the database offset is used in conjunction with the *LogicPro Soft_Bool or Soft_Int* I/O driver. The *LogicPro* IO Physical Address is constructed from the database offset only.

See the *LogicPro User's Guide* for specific instructions on addressing Boolean and Integer registers. See *Table 5.46 on page 206* for the *LogicPro* IO Physical Address of each register.

Soft Bool and Soft Int Registers

Table 5.46 lists the *LogicPro* IO Physical Address ranges, database offsets and first and last Modbus addresses for the Boolean and integer registers. These values are used when accessing Boolean and Integer registers with third-party software, operator interface terminals or *LogicPro* programs.

Table 5.45 Soft Bool Values

Value	AnaWin3 Value
0	False
1	True

These registers may be chosen as output destinations for a channel. See *Table 5.27 on page 190* for a list of output destinations values that includes these registers.

Table 5.46 Soft Bool and Soft Int Registers

AnaWin3 Name (Soft Bool and Soft Int Spreadsheets)	LogicPro I/O Physical Address[1]	Modbus Addressing	
		Decimal	Hex
PPC1: Soft Bool 1	1	3001	BB8
PPC1: Soft Bool 2	2	3002	BB9
⋮	⋮	⋮	⋮
PPC1: Soft Bool 1000	1000	4000	F9F
PPC1: Soft Int 1	1	46301	189C
PPC1: Soft Int 2	2	46302	189D
⋮	⋮	⋮	⋮
PPC1: Soft Int 100	100	46400	18FF
PPC1: Soft Int 101	101	47001	1B58
PPC1: Soft Int 102	102	47002	1B59
⋮	⋮	⋮	⋮
PPC1: Soft Int 2100	2100	49000	2327

[1]Use this address with the Soft_Bool or Soft_Int *IO Driver* when addressing the Soft Boolean and Soft Integer Registers.

Global Parameters in the Database

These system parameters are global and not relative to channels or I/O hardware addresses.

Accessing Global Parameters with Modbus

Some global parameters have only one Modbus address others use a range of addresses. *Table 5.48 on page 208* and *Table 5.51 on page 209* list first and last Modbus address for the global parameters. Use Modbus addresses when accessing global parameters with third-party software or operator interface terminals.

See the parameter descriptions for addressing details.

Accessing Global Parameters with *LogicPro*

When a logic program variable accesses global parameters, the parameter number (#) and the offset are used in conjunction with the *LogicPro* Database I/O driver. The I/O physical address is constructed from the parameter number and the database offset.

See the *LogicPro User's Guide* for specific instructions on addressing global parameters. See *Table 5.48 on page 208* and *Table 5.51 on page 209* for the parameter number (#) and the parameter descriptions for database offsets for each global parameter.

Communications Parameters

For multiple PPC installations, each PPC must have a unique network address. As many as 32 PPC systems may communicate on a network. Network addresses 1 through 4 can be set using the rotary switch on the processor module.

Use setting **D** and *PPCComSU* to program the remaining addresses (5-32). Refer to *Setting Programmable Modbus Addresses on page 87* for programming information.

Changed communication parameters do not take affect until the controller resets or cycles power, and only with the appropriate rotary switch settings on the Processor module.

NOTE! ***Do not cycle power with the rotary switch set in positions E-G unless specifically directed to do so. These positions are used for clearing memory and other functions. Parameter settings can be lost. See Chapter 4, Troubleshooting, for more on these switch settings.***

Table 5.47 Rotary Switch Configuration

Position	Network Address
A	Fixed: 1
B	Fixed: 2
C	Fixed: 3
D	Programmable, Default: 4
E-G	N/A
H	Fixed: 1

Switch settings **A-D** have the following settings:

- 19.2 kbaud (programmable)
- Even parity (fixed)
- 8 data bits (fixed)
- 1 stop bit (fixed)

Switch setting **H** has the following fixed settings:

- 19.2 kbaud
- Even parity
- 8 data bits
- 1 stop bit

Switch settings **E-G** are Reserved.

Table 5.48 lists the parameter number (#) range, and first and last Modbus addresses for the communications parameters.

Table 5.48 Communications Parameters

Parameter	#	Range	Modbus Address	Hex Address
Baud Rate	119		46171-46180	181A-1823
Address	122	1-247	46191-46200	182E-1837

Baud Rate

Select the communications baud rate for the corresponding port.

Table 5.49 Database Offsets for Baud Rate

Database Offset	Description
1	Port 1
2	Port 2

Table 5.50 Baud Rate

Value	Baud Rate
9600	9600
19200	19200

Address

This is the Modbus communications network address to which the PPC will answer on ports 1 and 2.

Global Database Parameters

Table 5.51 lists parameter number (#), range, and first and last Modbus addresses for the remaining global parameters. These values are used when accessing global parameters with third-party software, operator interface terminals or *LogicPro* programs.

Table 5.51 System HW Parameters

Parameter	#	Range	Modbus Address	Hex Address	Notes
Full Scale	142	-32768 to 32767	33451-33500	D7A-DAB	See *Table 5.52*
Zero Reference	143	-32768 to 32767	33501-33550	DAC-DDD	See *Table 5.54*
Modules Present	113	0-255	33551-33750	DDE-EA5	See Table 5.56 and Table 5.57
Ambient Temperature	140	-32768 to 32767	33751-33770	EA6-EB9	See Table 5.55

Table 5.52 Miscellaneous System Parameters

Parameter	#	Range	Modbus Address	Hex Address	Notes
System Status	106	0-1	10001-10050	0-31	See Table 5.59 and Table 5.60
System Commands	105	0-1	04051-04100	FD2-1003	See Table 5.57
Changed Data Queue	107	0-255	33051-33150	BEA-C4D	
Program Version	108	0-255	33151-33200	C4E-C7F	See Table 5.60
System Error Log	112	0-255	33201-33450	C80-D79	
Time and Date	114	0-99	46151-46157	672-678	See Table 5.63

Full Scale

The values stored in the **Full Scale** registers are the readings from the high voltage references. These readings are used in conjunction with the zero reference readings to scale the analog input readings.

Table 5.53 Full Scale Readings

Database Offset	Module Address	Range	Reference Voltage
1	1	-1 to 10V	10V
2	1	-5 to 50mV	50mV
3	2	-1 to 10V	10V
4	2	-5 to 50mV	50mV
5	3	-1 to 10V	10V
6	3	-5 to 50mV	50mV
7	4	-1 to 10V	10V
8	4	-5 to 50mV	50mV

Zero Reference

The values stores in the **Zero Reference** registers are the readings from the low voltage reference. These readings are used in conjunction with the **Full Scale** reading to scale the analog input readings.

Table 5.54 Zero Reference Readings

Database Offset	Module Address	Range	Reference Voltage
1	1	-1 to 10V	0V
2	1	-0.5 to 5V	0V
3	1	-0.1 to 1V	0V
4	1	-50 to 500mV	0V
5	1	-10 to 100mV	0V
6	1	-5 to 50mV	0V
7	2	-1 to 10V	0V
8	2	-0.5 to 5V	0V
9	2	-0.1 to 1V	0V
10	2	-50 to 500mV	0V
11	2	-10 to 100mV	0V
12	2	-5 to 50mV	0V
13	3	-1 to 10V	0V
14	3	-0.5 to 5V	0V
15	3	-0.1 to 1V	0V
16	3	-50 to 500mV	0V
17	3	-10 to 100mV	0V
18	3	-5 to 50mV	0V
19	4	-1 to 10V	0V
20	4	-0.5 to 5V	0V
21	4	-0.1 to 1V	0V
22	4	-50 to 500mV	0V
23	4	-10 to 100mV	0V
24	4	-5 to 50mV	0V

Ambient Temperatures

The analog input modules measure the temperatures of each terminal block on up to 4 AITBs in tenths of a degree Fahrenheit.

These give the cold junction compensation temperature in degrees F for each half of the terminal block. Note that the channel numbers associated with a given cold junction reference depend on whether the card is single ended or differential.

Table 5.55 Ambient Temperature Readings

Database Offset	Module Address	Associated AITB Connectors
1	1	TB1 and TB2
2	1	TB3 and TB4
3	2	TB1 and TB2
4	2	TB3 and TB4
5	3	TB1 and TB2
6	3	TB3 and TB4
7	4	TB1 and TB2
8	4	TB3 and TB4

Modules Present

Eight registers are required to describe the features and capabilities of each module. As many as 12 modules may be inventoried on start-up, totalling 96 registers. After the inventory routines run, the registers are updated with the current configuration. Refer to *Table 5.56* and *Table 5.57 on page 212*. These settings are read-only.

Table 5.56 Modules Present

Database Offset	Description	Range
1	Type of Module	0-9
2	Module number (rotary switch address)	0-14
3	Number of digital inputs	0-48
4	Number of digital outputs	0-48
5	Number of analog inputs	0-32
6	Number of analog outputs	0-8
7	Number of frequency / counter inputs	0-4
8	Reserved	n/a

For modules with configurable I/O, the total number of potential inputs and outputs are set in the corresponding registers. For example, the Processor module inventory returns 24 digital inputs and 46 digital outputs. The count of analog outputs does not include outputs that can be configured for SDACs.

Table 5.57 Module Types

Value	Description
0	No module
1	PPC-2010
2	Reserved
3	PPC-2021, 2024, 2025
4	PPC-2022
5	PPC-2030
6	PPC-2040
7	PPC-2050, 2051
8	PPC-2061, 2062
9	PPC-2070, 2071, 2072, 2073

System Commands

System Commands force specific actions within the controller. Write a 1 in the register to execute the corresponding command. Some command bits are executed and reset to 0 by the controller immediately after a host writes a 1. Other command bits are latched in whatever state was last written. *Table 5.58* lists each type.

Table 5.58 System Commands

Database Offset	Modbus Address	Name	Reset After Host Write	Action
1	04051	Reload Defaults	Reset	Load defaults to most run-time parameters. The exceptions are protocol, baud, parity, address, system HW config, system commands, system status, program version, change data queue, system error log, real time clock and analog input calibration data.
2	04052	Reserved	N/A	
3	04053	Reserved	N/A	
4	04054	RAM Clear Reset	Reset	Clear RAM, reset controller and load defaults
5	04055	Watchdog Test	Reset	Force watchdog timeout
6	04056	Start Logic	Reset	Start logic program
7	04057	Reserved	N/A	
8	04058	Stop Logic	Reset	Stop logic program
9	04059	Loop Startup	Latched	0=Start control loops in off mode. Undo not available. 1=Start control loops from last mode stored in memory.
10	04060	AC Frequency	Latched	0=60Hz 1=50Hz
11	04061	Logic Startup	Latched	0=Start logic program when commanded. 1=Start logic program on startup.
12	04062	Reset PPC	Reset	Reset controller

System Status

Provides information about various controller functions and errors. These values are read-only. Some status bits are sets to 0 after being read by a host. Other status bits are not affected by host reads and are latched in whatever state the controller determines. See *Table 5.59* .

Table 5.59 System Status

Database Offset	Modbus Address	Name	Reset After Host Read	Description
1	10001	Defaults Loaded	Reset	Default values have been loaded
2	10002	Reserved	N/A	
3	10003	Reserved	N/A	
4	10004	Controller has reset	Reset	Controller has reset
5	10005	Ambient Status	Latched	Ambient temperature error
6	10006	H/W Cfg Status	Latched	Hardware configuration error
7	10007	Battery Status	Latched	Battery voltage is low
14	10014	Logic Run Status	Latched	Logic program is running
15	10015	Logic Load Status	Latched	Logic program is loaded

The values of the bits in the **System Status Registers** are interpreted according to the following table:

Table 5.60 System Status Bits

Value	Status
0	no error / false
1	error / true

Program Version

Embedded program version label for the firmware program.

Table 5.61 Program Version Information

Database Offset	Description
1	Major version, first digit
2	Major version, second digit
3	Minor version, first digit
4	Minor version, second digit
5	Release level alpha character
6	Reserved
7	Reserved
8	Reserved

Changed Data Queue

The **Changed Data Queue** is a tool for hosts which need to maintain a mirror image database of the PPC-2000 database. Typically, these are PC based hosts. Most simple operator interfaces, such as operator interface terminals, constantly query the PPC for only the information that needs to be displayed on the current screen. These devices would not read the queue.

The PPC-2000 can communicate with 1 or 2 host devices with read/write capability. If 2 hosts are used, the changed data queue alerts port 1 host that port 2 host has changed a section(s) of the database and vice versa. Each port has a dedicated queue which must be continuously monitored by the respective host. The addresses are the same for both ports, but the data in each queue may differ because port 1 queue monitors port 2 activity while port 2 queue monitors port 1 activity.

The queue consists of a group of read-only registers. Register 33051 contains the quantity of parameters which have been changed by the other host. Registers 33052-N form a first-in-first-out stack of changed parameters consisting of the parameter ID numbers. The queue does not report the changed status of specific elements within a parameter but only the parameter ID number that has been changed. Therefore, if the changed data queue notifies host 1 that host 2 has changed a parameter, it is necessary for host 1 to read all elements within a parameter to update host 1's database.

Using a First In First Out (FIFO) stack, the queue logs all changes to the database originating from another host. Register 33052 contains the oldest change logged, 33053 contains the second oldest and so on. After the host reads the register(s), the data is cleared and shifted in the FIFO stack.

It is necessary to begin any host read command (Modbus function 04) with register 33051. Read requests that do not start at 33051 are not supported. It is not necessary to continually read the entire queue at once. A recommended technique is to read the first 8 registers of the queue on a periodic basis. If there are more than 7 changes in the queue, then subsequent changes would be shifted down so that the next time the queue is read the host will pick up the changes.

System Error Log

The **System Error** log indicates how many times particular failures have occurred since the last time the error log was cleared. The first register contains a total count of system errors. The last register contains a number of unidentified or illegal error codes logged. Refer to *Table 5.62 on page 217*. The counts stop incrementing at 255.

Table 5.62 System Error Log

Data-base Offset	Modbus Address	Name	Description
1	33201	Error Count	Total error count (255 maximum)
22	33222	Logic Checksum	Bad checksum in a logic program hex record
24	33224	Logic Load	Error verifying programming of a logic program hex record
42	33242	Undefined Parm#	Parameter number outside the range of the database
43	33243	Bad Data Sent	Attempt to write data outside of a parameter's range
44	33244	Bad Offset	Parameter offset beyond last element of the parameter
45	33245	Parm Size	Internal error in parameter size during read or write
47	33247	Database Reg	Internal error registering database entry
48	33248	Write to RO	Attempt was made to write to a read only variable
49	33249	Change Q Overflow	Overflow in database change queue
51	33251	Bad Flash Type	Flash type was not found in table
52	33252	Flash Overflow	Attempted write past end of flash
53	33253	Program Verify	Failed program verify test
61	33261	Bad Interrupt	Received bad interrupt
66	33266	Divide by Zero	Divide by zero exception
67	33267	Illegal OpCode	Illegal opcode exception
71	33271	AI Address	Multiple AI boards detected at one address
73	33273	AI Cal Data	AI board has invalid calibration data
74	33274	AI Timeout	System unable to process AI input on time
75	33275	CMO or Open T/C	CMO or OTC occurred on an AI channel
92	33292	Bad Baud Rate	Configured baud rate not supported
93	33293	UART Not Found	A UART not detected
94	33294	Wrong Port	Internal error: attempt to configure unsupported port
96	33296	Closed Port	Internal error: attempt to access port that isn't open
97	33297	Bad Parity	Internal error: attempt to configure unsupported parity
101	33301	Bad CRC	Modbus message CRC did not match
102	33302	Bad Modbus Func	Modbus message attempted unsupported function
103	33303	Invalid Address	Invalid Modbus register address
104	33304	Pckt Ln or Func	Bad Modbus packet length or diagnostic subfunction
107	33307	Packet Length	Bad Modbus packet length
108	33308	Bad Address	Bad Modbus register address
111	33311	Missed I/O Update	Internal error: missed I/O update deadline
129	33329	Bad Error Msg	Internal error: attempted to post error of 128 or greater

Time and date

The PPC-2000's clock calendar automatically updates the year, day of the week, month, date, hour, minute and second. The time and date can be set initially with a PC or similar host. The information located in seven registers can be used in logic programs or a host computer. *Table 5.63* describes the data format.

Table 5.63 Real Time Clock Format

Database Offset	Description	Range
0	Year	0 to 99
1	Day of Week[1]	1 to 7
2	Month	1 to 12
3	Date	1 to 31
4	Hours	0 to 23
5	Minutes	0 to 59
6	Seconds	0 to 59

[1] The values for day of the week are not predefined. They are incremented with the date. The user chooses what day equals a value of one, and the rest of the day values follow.

6

Tuning and Control

This chapter describes the different methods of control available with the your controller. This section covers:

- On/Off Control
- Proportional Control
- Proportional and Integral Control
- PID Control
- Control Outputs
- Tuning PID Loops
- PID Constants by Application

Introduction

This chapter explains PID control and supplies some starting PID values and tuning instructions to help appropriately set control parameters in the PPC system. For more information on PID control, consult the *Watlow Anafaze Practical Guide to PID*.

The control algorithm dictates how the controller responds to an input signal. Do not confuse control algorithms with control output signals (for example, analog or pulsed DC voltage). There are several control algorithms available: **On/Off**, Proportional (**P**), Proportional and Integral (**PI**), Proportional with Derivative (**PD**), and Proportional with Integral and Derivative (**PID**). **P**, **PI**, or **PID** control is necessary when process variable (**PV**) cycling is unacceptable or if the process or setpoint (**SP**) is variable.

NOTE! ***For any of these control modes to function, the channel must be in automatic mode.***

Control Algorithms

The next sections explain the different methods for controlling a loop.

On/Off Control

On/Off control is the simplest way to control a process; a controller using On/Off control turns an output on or off when the process variable reaches limits around the desired setpoint. This limit is adjustable; Watlow Anafaze controllers use an adjustable spread.

For example, if the set point is 1000°F, and the spread is 20°F, the heat output switches On when the process variable drops below 980°F and Off when the process rises above 1000°F. A process using On/Off control cycles around the set point. *Figure 6.1* illustrates this example.

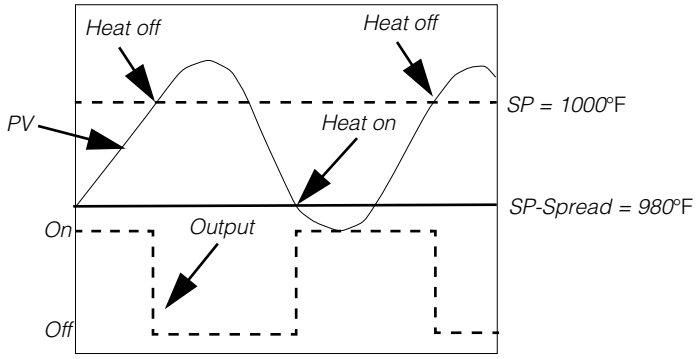


Figure 6.1 On/Off Control

Proportional Control

Proportional control eliminates cycling by increasing or decreasing the output in proportion to the process variable's deviation from the setpoint.

The magnitude of proportional response is defined by the Proportional Band (PB); outside this band, the output is either 100% or 0%. Within the proportional band the output power is proportional to the PV's difference from the setpoint.

For example, if the setpoint is 1000°F and the PB is 20°F, the output is:

- 0% when the process variable is 1000°F or above
- 50% when the process variable is 990°F
- 75% when the process variable is 985°F
- 100% when the process variable is 980°F or below.

However, a process which uses only proportional control settles at a point above or below the setpoint; it never reaches the setpoint by itself. This behavior is known as offset or droop.

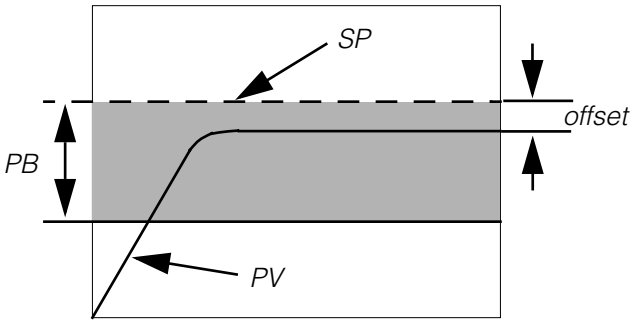


Figure 6.2 Proportional Control

Proportional and Integral Control

With proportional and integral control, the integral term corrects for offset by repeating the proportional band's error correction until there is no error. For example, if a process tends to settle about 5°F below the set point, appropriate integral control brings it to the desired setting by gradually increasing the output until there is no deviation.

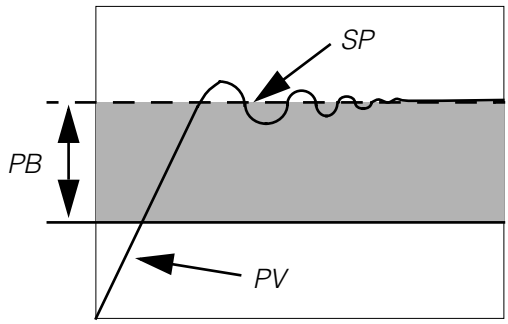


Figure 6.3 Proportional and Integral Control

Proportional and integral action working together can bring a process to setpoint and stabilize it. However, with some processes the user may be faced with choosing between parameters that make the process very slow to reach setpoint and parameters that make the controller respond quickly, but introduce some transient oscillations when the setpoint or load changes.

Proportional, Integral and Derivative Control

Derivative control corrects for overshoot by anticipating the behavior of the process variable and adjusting the output appropriately. For example, if the process variable is rapidly approaching the set point from below, derivative control reduces the output, anticipating that the process variable will reach set point. Use derivative control to reduce the overshoot and oscillation of the process variable common to PI control. *Figure 6.4* shows a process under full PID control.

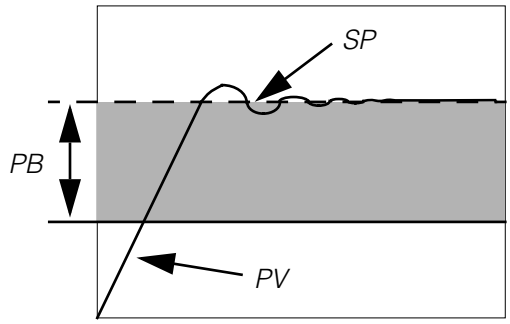


Figure 6.4 Proportional, Integral and Derivative Control

Control Outputs

The controller provides open collector and analog outputs for control. Open collector outputs normally control the process using solid state relays.

Open collector outputs can be configured to drive a Serial Digital-to-Analog Converter (SDAC), that in turn, can provide 0-5Vdc, 0-10Vdc or 4-20mA control signals to operate field output devices.

Output Control Forms

The following sections explain the various control output signals available.

On/Off

When On/Off control is used, the output is on or off depending on the difference between the setpoint and the process variable. PID algorithms are not used with On/Off control. The output variable is always off or on (0% or 100%).

Time Proportioning (TP)

With time proportioning outputs, the PID algorithm calculates an output between 0 and 100%, which is represented by turning on an output for that percent of a fixed, user-selected time base or cycle time. The cycle time is the time over which the output is proportioned, and it can be any value from 1 to 255 seconds. For example, if the output is 30% and the cycle time is 10 seconds, then the output will be on for 3 seconds and off for 7 seconds. *Figure 6.5* shows example TP and Distributed Zero Crossing (DZC) waveforms.

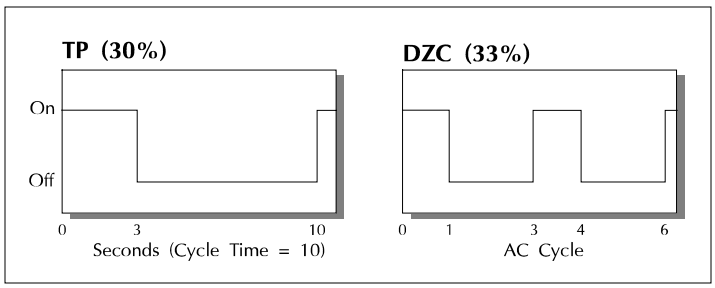


Figure 6.5 Example Time Proportioning and Distributed Zero Crossing Waveforms

Distributed Zero Crossing (DZC)

With DZC outputs, the PID algorithm calculates an output between 0 and 100%, but the output is switched on a variable time base. For each AC line cycle the controller decides whether the power should be on or off. There is no fixed cycle time since the decision is made for each line cycle. When used in conjunction with a zero crossing device, such as an SSR, switching is done only at the zero crossing of the AC line, which helps reduce electrical noise.

Using a DZC output should extend the life of heaters. Since the time period for 60Hz power is 16.6 ms, the switching interval is very short and the power is applied uniformly. DZC should be used with SSRs. Do not use DZC output for electromechanical relays.

The combination of DZC output and a solid state relay can inexpensively approach the effect of analog, phase-angle fired control. Note, however, DZC switching does not limit the current or voltage applied to the heater as phase-angle firing does.

Analog Outputs

For analog outputs, the PID algorithm calculates an output between 0 and 100%. This percentage of the analog output range can be applied to an output device via an analog module or a digital module in conjunction with an SDAC.

Output Filter

The output filter smooths PID control output signals. It has a range of 0-255 scans, which gives a time constant of 0-170 seconds for the PPC. Use the output filter if you need to filter out erratic output swings due to extremely sensitive input signals, like a turbine flow signal or an open air thermocouple in a dry air gas oven.

The output filter can also enhance PID control. Some processes are very sensitive and would otherwise require a large PB, making normal control methods ineffective. Using the output filter allows a smaller PB to be used, achieving better control.

Also, use the digital filter to reduce the process output swings and output noise when a large derivative is necessary, or to make badly tuned PID loops and poorly designed processes behave properly.

Setting Up and Tuning PID Loops

After installing your control system, tune each control loop and then set the loop to automatic control. (When tuning a loop, choose PID parameters that will best control the process.) This section gives PID values for a variety of heating and cooling applications.

NOTE! ***Tuning is a slow process. After adjusting a loop, allow about 20 minutes for the change to take effect.***

Proportional Band (PB) Settings

Table 6.1 shows PB settings for various temperatures in degrees Fahrenheit.

Table 6.1 Proportional Band Settings

Temperature Setpoint	PB	Temperature Setpoint	PB	Temperature Setpoint	PB
-100 to 99	20	1100 to 1199	75	2200 to 2299	135
100 to 199	20	1200 to 1299	80	2300 to 2399	140
200 to 299	30	1300 to 1399	85	2400 to 2499	145
300 to 399	35	1400 to 1499	90	2500 to 2599	150
400 to 499	40	1500 to 1599	95	2600 to 2699	155
500 to 599	45	1600 to 1699	100	2700 to 2799	160
600 to 699	50	1700 to 1799	105	2800 to 2899	165
700 to 799	55	1800 to 1899	110	2900 to 2999	170
800 to 899	60	1900 to 1999	120	3000 to 3099	175
900 to 999	65	2000 to 2099	125	3100 to 3199	180
1000 to 1099	70	2100 to 2199	130	3200 to 3299	185

As a general rule, set the PB to 10% of the setpoint below 1000° and 5% of the setpoint above 1000°. This setting is useful as a starting value.

Integral Settings

The controller's Integral parameter is set in seconds per repeat. Some other products use an integral term called Reset, in units of repeats per minute. *Table 6.2 on page 227* shows Integral settings versus Reset settings.

Table 6.2 Integral Term and Reset Settings

Integral (sec/repeat)	Reset (repeat/min)		Integral (sec/repeat)	Reset (repeat/min)
30	2.0		210	0.28
45	1.3		240	0.25
60	1.0		270	0.22
90	0.66		300	0.20
120	0.50		400	0.15
150	0.40		500	0.12
180	0.33		600	0.10

As a general rule, use 60, 120, 180, or 240 as a starting value for the Integral.

Derivative Settings

The controller's Derivative parameter is programmed in seconds. Some other products use a derivative term called Rate programmed in minutes. Use the table or the formula to convert parameters from one form to the other. *Table 6.3* shows Derivative versus Rate; Rate = Derivative/60.

Table 6.3 Derivative Term vs. Rate

Derivative (seconds)	Rate (minutes)		Derivative (seconds)	Rate (minutes)
5	0.08		35	0.58
10	0.16		40	0.66
15	0.25		45	0.75
20	0.33		50	0.83
25	0.41		55	0.91
30	0.50		60	1.0

As a general rule, set the Derivative to 15% of Integral as a starting value.

NOTE! ***While the basic PID algorithm is well defined and widely recognized, various controllers implement it such that parameters may not be taken from one controller and applied to another with optimum results even if the above unit conversions are performed.***

General PID Constants by Application

This section gives PID values for many applications. They are useful as control values or as starting points for PID tuning.

Proportional Band Only (P)

Set the Proportional Band to 7% of the Setpoint.
(Example: Setpoint = 450: Proportional Band = 31).

Proportional with Integral (PI)

Set the Proportional Band to 10% of Setpoint.
(Example: Setpoint = 450: Proportional Band = 45).

Set Integral to 60.
Set Derivative to Off.
Set the Output Filter to 2.

PI with Derivative (PID)

Set the Proportional Band to 10% of the Setpoint.
(Example: Setpoint = 450: Proportional Band = 45).

Set the Integral to 60.
Set the Derivative to 15% of the Integral.
(Example: Integral = 60: Derivative = 9).
Set the Output Filter to 2.

Table 6.4 shows general PID constants by application.

Table 6.4 General PID Constants

Application	Proportional Band	Integral	Derivative	Filter	Output Type	Cycle Time
Electrical heat with SSR	50°F	60	15	4	DZC	-
Electrical heat with EM relays	50°F	60	15	6	TP	20
Cool w/ solenoid valve	70°F	500	90	4	TP	10
Cool w/ fans	10°F	off	10	4	TP	10
Electric heat with open heat coils	30°F	20	off	4	DZC	-
Gas heat w/ motorized valves SP>1200	60°F 100°F	120 240	25 40	8	Analog	-

7

Specifications

The following sections contain specifications for the PPC-2000 system and each type of module. Specifications are subject to change without notice.

System Specifications

This section contains specifications for the PPC-2000 system as a whole.

Safety and Agency Approvals

Table 7.1 describes safety and agency approvals for the PPC-2000 system. Approvals apply to all PPC-2000 modules and peripherals except as noted in the specifications for individual modules or peripherals on the following pages.

Table 7.1 Safety and Agency Approvals

UL C-UL	3121-1 Listed, Category II Installation, File # E212113
CE Safety	EN 61010-1
CE EMC	EN 61326, EN 55011

Physical Specifications

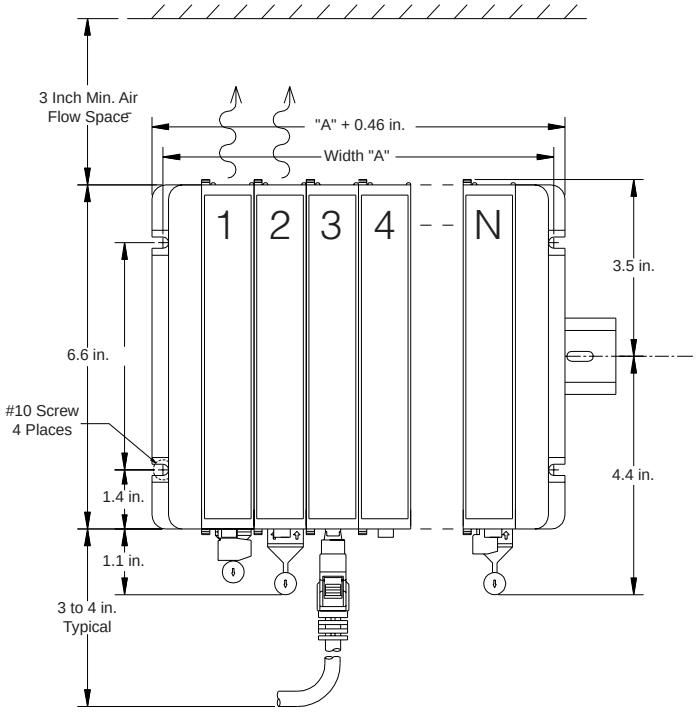


Figure 7.1 System Footprint

Table 7.2 PPC System Dimensions

Number of Modules	Width A	Overall Width
1	2.705 in.	3.165 in.
2	3.660 in.	4.120 in
3	4.615 in.	5.075 in.
4	5.570 in.	6.030 in.
5	6.525 in.	6.985 in.
6	7.480 in.	7.940 in.
7	8.435 in.	8.895 in.
8	9.390 in.	9.850 in.
9	10.345 in.	10.805 in.
10	11.300 in.	11.760 in.

Power Specifications

See *Chapter 2, Power Supply Requirements on page 13* to determine the power requirements for a PPC-2000 system.

PPC-2010 Processor Specifications

Up to 32 PPCs may be connected on a network. The default baud rate is 19200 and is configured via AnaWin3.

The processor module's front panel has two serial communications ports. Both Port 1 and Port 2 can be used with either RS-232 or RS-485 connections. Each port's baud rate, network address and format are configured via the rotary switch on the front panel.

The bottom panel includes a 50-pin SCSI connector and a 10-28Vdc power connector.

The processor module has 48 built in digital I/O points. 24 points are outputs only: 22 of these are user configurable for control, alarms, or logic program outputs and 2 are dedicated to system status and the global alarm. The remaining 24 I/O points are user-configurable as either inputs or outputs for control, alarms, or logic.

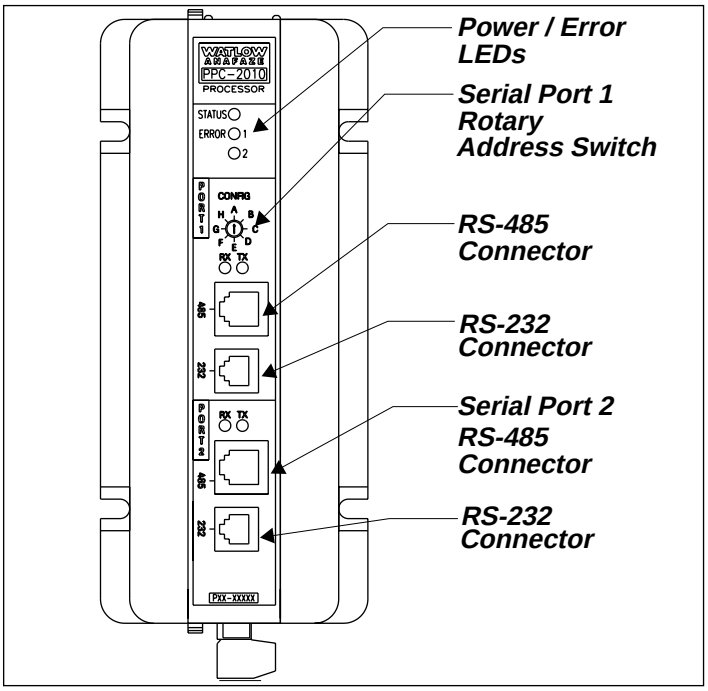


Figure 7.2 PPC-2010 Front View

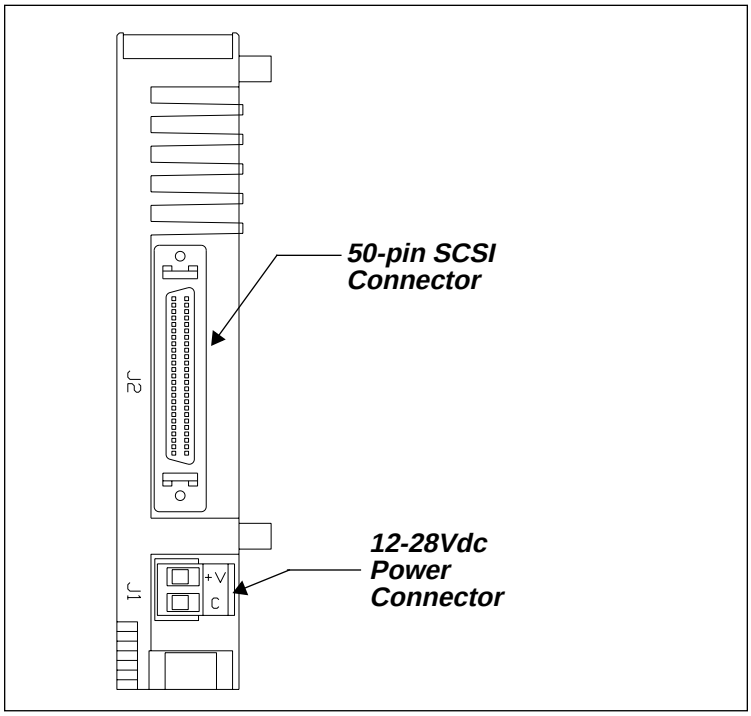


Figure 7.3 PPC-2010 Bottom View

Table 7.3 Model Number

PPC-2010	Processor

Table 7.4 Environmental Specifications

Storage Temperature	-20 to 70°C (-4º to 158°F)
Operating Temperature	0 to 60°C (32º to 140°F)
Humidity	10 to 95% non-condensing

Table 7.5 Physical Specifications

Weight	0.82 lbs	0.37 kg
Height	8.0 in.	203 mm
Width, including endcaps	3.2 in.	81 mm
Depth	5.25 in.	133 mm

Table 7.6 Connections

Power Terminals	Captive screw cage clamp
Power Wire Gauge	24 to 12 AWG
Power Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in.-lb)
Connector on Module	SCSI-2 female
Mounting	DIN rail or panel mount
Port 1 and Port 2	See *Table 7.13 on page 235*

Table 7.7 Power Specifications

System Power Requirement	12 to 26 ± 2 Vdc
Power	3 W typical
Current (@ 12Vdc)	250mA typical @ 25ºC
Current (@ 24Vdc)	125mA typical @ 25ºC
Max. Voltage between Ground and Common	40Vdc

Table 7.8 Capacity and Programming

Digital I/O Points on Processor	46
Max. Number Digital I/O Points	288
Max. Number of Counter Inputs	17
Max. Number of Additional I/O Modules	9
Max. Number of Analog Inputs	128
Max. Number of Analog Outputs (not counting DACs/SDACs)	48 (Requires 4 PPC-2030 and 4 PPC-2050.)
Program Capacity	Logic program memory: 128 kB. Data memory in battery-back RAM: 60 kB
Programming Language	IEC1131-3 compliant Ladder Diagram, SFC, and FBD
Number of Instructions	7 logic instructions, 42 applied instructions
Logic Program Storage	Flash memory
Logic Programming Software	*LogicPro*
Operating System for Programming Software	Windows95/98, WindowsNT

Table 7.9 Control Specifications

Control Modes	On/Off, P, PI, or PID
Number of Control Loops	48* programmable channels. Channels may be single or dual output
Control Outputs	Time proportioning, Distributed Zero Crossing, On/Off or analog all independently selectable for each loop.
Time Proportioning Cycle Time	1 to 255 seconds
Control Action	Reverse (heat) or direct (cool)
Alarm Outputs	Independently set high/low process alarms and high/low deviation alarms.
Tuning	Auto or manual
Soft Input Update	1 sec.

**Additional I/O modules required.*

Table 7.10 Counter/Frequency Input Specifications

Number	1
Maximum Frequency	10 kHz single-phase
Sample Rate	250 ms (4 Hz)
Voltage Levels	<0.6 = Low; 3.8V = High
Max. Input Current	0.5mA from processor with input at 0V
Input Resistance	6 kOhms Min.
Count Range	16 bits

Table 7.11 Digital Input Specifications

Number	24**
Voltage Limiting and Protection	40Vdc
Voltage Levels	<0.6 = Low; 3.8V = High
Max. Input Current	0.5mA from processor with input at 0V
Max. Switch Resistance to Pull Input Low	1 kOhm
Min. Switch Off Resistance	27 kOhm

Table 7.12 Digital Output Specifications

Number	48**
Configuration	1 global alarm 1 system status (CPU watchdog timer) 22 control outputs 24 configurable as inputs or control outputs
Max. Voltage	24Vdc
Max. Current	100mA sink to power common continuous
Off State Leakage Current, Outputs 1 to 24	100µA
Off State Leakage Current, Outputs 25-48	5µA
On State Maximum Voltage	≤ 0.7Vdc (output to common)

*** The PPC-2010 has 48 built-in digital I/O points. 24 points are outputs only. 22 of the outputs are user configurable for PID control, alarms or logic outputs. The other 2 outputs are dedicated to system status and global alarm. The remaining 24 I/O points are individual configurable as either inputs or outputs.*

Table 7.13 Serial Interface

Number of Ports	2
Type	RS-232 3-wire or RS-485 5-wire
Modular Jacks	RS-232: 4 position, 4 conductor (phone handset) RS-485: RJ12 6 position, 6 conductor
Isolation	40Vdc working, ± 200Vdc peak
Baud Rate	19200 default, configurable 9600 or 19200
Error Check	CRC
# of Controllers	1 with RS-232; 32 with RS-485
Protocol	Modbus RTU

PPC-2021 - 2025 Analog In/Analog In High Isolation Specifications

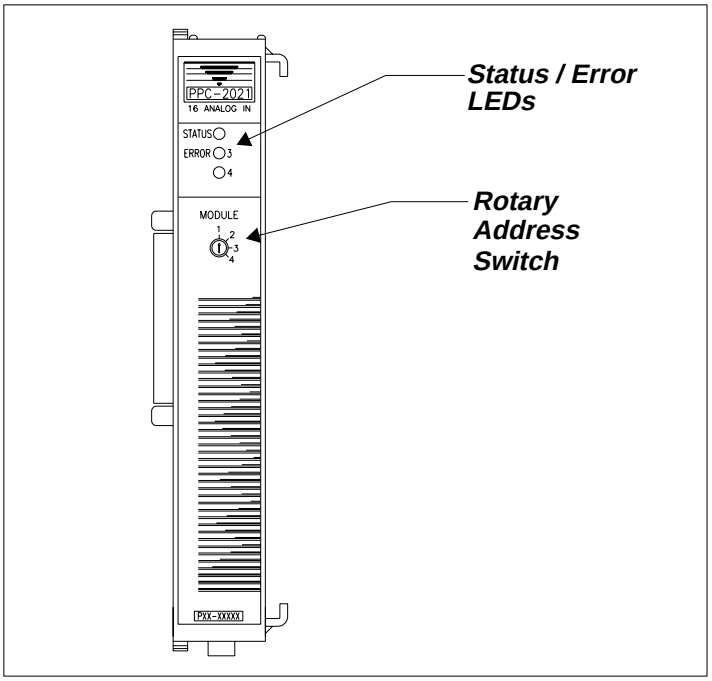


Figure 7.4 PPC-2021 Front View

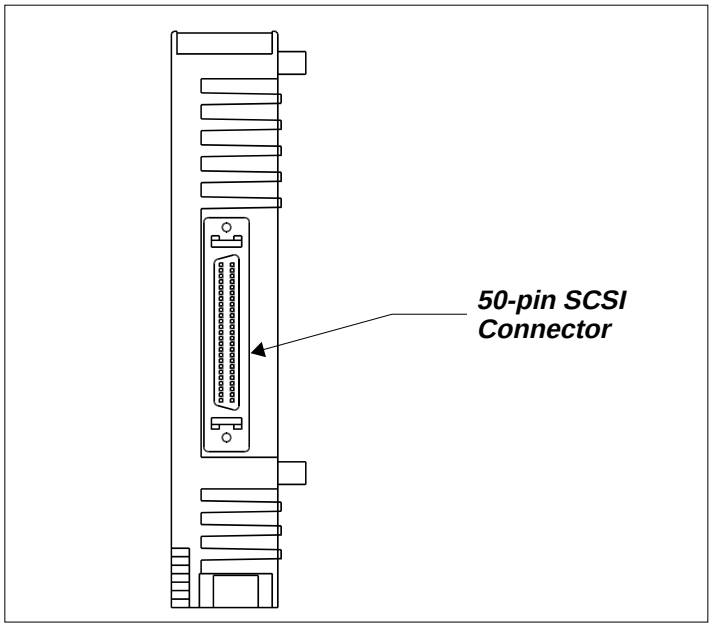


Figure 7.5 PPC-2021 - 2025 Bottom View

The Analog In modules' addresses are configured with the rotary switch.

The bottom panel includes a 50-pin SCSI connection for the Analog Input Terminal Board (AITB).

Table 7.14 Model Numbers

PPC-2021	16 input, analog input module, differential
PPC-2022	32 input, analog input module, single-ended
PPC-2024	8 input, high isolation analog input module
PPC-2025	16 input, high isolation analog input module

Table 7.15 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
Humidity	10 to 95% non-condensing

Table 7.16 Physical Specifications

Weight	0.6 lbs	0.27 kg
Height	8.0 in.	203 mm
Width	1.5 in.	38 mm
Depth	5.25 in.	133 mm
Mounting	DIN rail or panel mount	

Table 7.17 Connections

Connector on Module	SCSI-2 female

Table 7.18 Power Specifications

Power Requirement	4.7 W typical
Current (@ 12Vdc)	390mA typical @ 25°C
Current (@ 24Vdc)	195mA typical @ 25°C
Modules per Processor	4

Table 7.19 Analog Input Specifications

Analog Inputs	8 or 16 differential 32 single-ended
Nominal Isolation	Input to bus: 500Vdc continuous Input to frame ground: 120Vac Between inputs: ±60Vac (PPC-2021) Between inputs: 240Vac (PPC-2024, 2025) Between inputs: no isolation (PPC-2022)
Calibration	Automatic zero and full scale
Normal Mode Rejection Ratio (between + and - inputs)	60 dB @ dc to 1000Hz with 500 ohm input impedance
Common Mode Rejection Ratio* (between input and frame ground)	120 dB @ dc to 1000Hz with 500 ohm input impedance
A/D Conversion	Integrating voltage to frequency
DC Voltage Input Range	-1 to 10Vdc; ranges selectable 0 to 50mV, 0 to 100mV, 0 to 500mV, 0 to 1V, 0 to 5V, 0 to 10V
Current Input Range	0 to 20mA; ranges selectable 0 to 20mA or 4 to 20mA
RTD Input	100 ohm Pt, 3 wire
T/C Open Detect	2.5 kOhms or more (upscale)
Source Impedance	Measurements are within specification up to 500 ohm source resistance
Resolution	0.003% greater than 15 bits
Accuracy (voltage)	0.05% at 25ºC (PPC-2021, 2024, 2025) 0.1% at 25ºC (PPC-2022)
Accuracy (current)	0.1% at 25ºC (PPC-2021, 2024, 2025) 0.75% at 25°C (PPC-2022)
Temperature Coefficient	<50 ppm/ºC, 0.005%/ºC
Sample Rate @ 60 Hz, PPC-2021, PPC-2025	380 msec to sample all 16 channels (2.6 Hz)
Sample Rate @ 60 Hz, PPC-2022	666 msec to sample all 32 channels (1.5 Hz)
Sample Rate @ 60 Hz, PPC-2024	220 msec to sample all 8 channels (4.5 Hz)

*Not applicable to PPC-2022

Table 7.20 Temperature Sensor Accuracy

Type	Range	Resolution	Total Accuracy
B T/C	32° to 3308°F (0 to 1820°C)	±0.32°F (±0.18°C)	±5.9°F (±3.3°C)
C T/C	32 to 4200°F (0 to 2316°C)	±0.02°F (±0.01°C)	±2.8°F (±1.6°C)
D T/C	32 to 4200°F (0 to 2316°C)	±0.02°F (±0.01°C)	±2.7°F (±1.5°C)
E T/C	-454 to 1221°F (-270 to 661°C)	±0.08°F (±0.04°C)	±1.8°F (±1.0°C)
F T/C (Platinel2)	32 to 2250°F (0 to 1232°C)	±0.19°F (±0.11°C)	±4.1°F (±2.3°C)
G T/C	32 to 4200°F (0 to 2316°C)	±0.02°F (±0.01°C)	±2.7°F (±1.5°C)
J T/C	-346 to 1598°F (-210 to 870°C)	±0.07°F (±0.04°C)	±2.1°F (±1.2°C)
K T/C	-454 to 2249°F (-270 to 1232°C)	±0.17°F (±0.09°C)	±3.9°F (±2.2°C)
N T/C	-454 to 2372°F (-270 to 1300°C)	±0.08°F (±0.04°C)	±2.7°F (±1.5°C)
R T/C	-58 to 3215°F (-50 to 1768°C)	±0.02°F (±0.01°C)	±4.6°F (±2.6°C)
RTD 100 Ohm Plat	-418 to 521°F (-250 to 272°C)	±0.04°F (±0.02°C)	±0.8°F (±0.4°C)
RTD 100 Ohm Plat High	-418.0 to 1562.0°F (-250.0 to 850.0°C)	±0.14°F (±0.08°C)	±4.2°F (±2.3°C)
S T/C	-58 to 3215°F (-50 to 1768°C)	±0.31°F (±0.17°C)	±5.6°F (±3.1°C)
T T/C	-454 to 752°F (-270 to 400°C)	±0.07°F (±0.04°C)	±2.1°F (±1.2°C)
Thermistor 100K Ohm	-24.78°F to 327°F (-31.54 to 163.89°C)	±0.01°F (±0.006°C)	±0.08°F (±0.04°C)

Table 7.21 Sensor Reference Voltage Output

Voltage	10Vdc ± 0.3Vdc @ 25°C
Maximum Current	20mAdc

PPC-2030 Encoder In Analog Out Specifications

5Vdc is supplied at a maximum of 60mA per encoder. An external terminal block is used to interface to the encoders.

The analog output is isolated (12Vac) individually from processor and bus power common. In both voltage and current modes, the return is to the analog common.

The PPC-2030 bottom panel includes two encoder input 15-pin HD connectors and two analog output connections with two, 4-position plug type connectors. Each signal has a dedicated return.

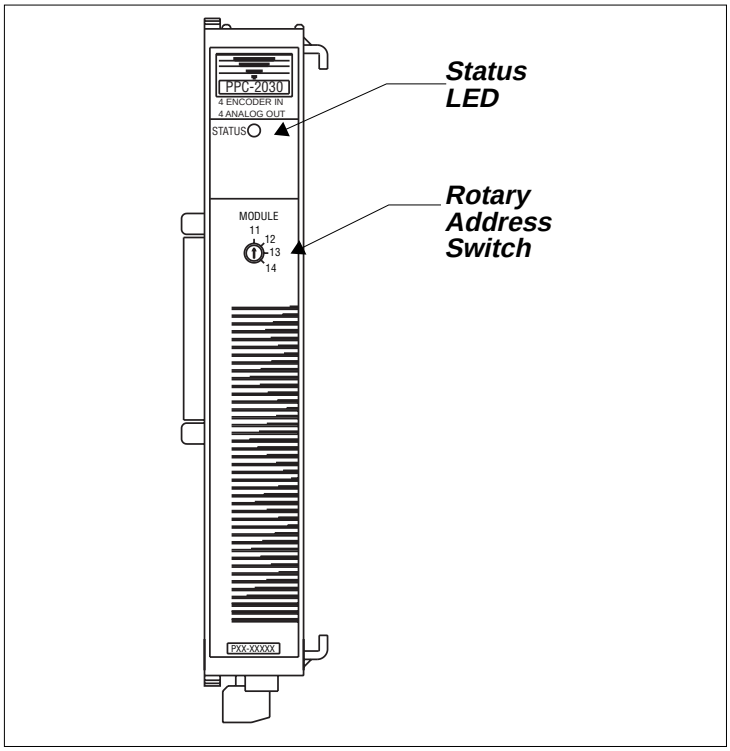


Figure 7.6 PPC-2030 Front View

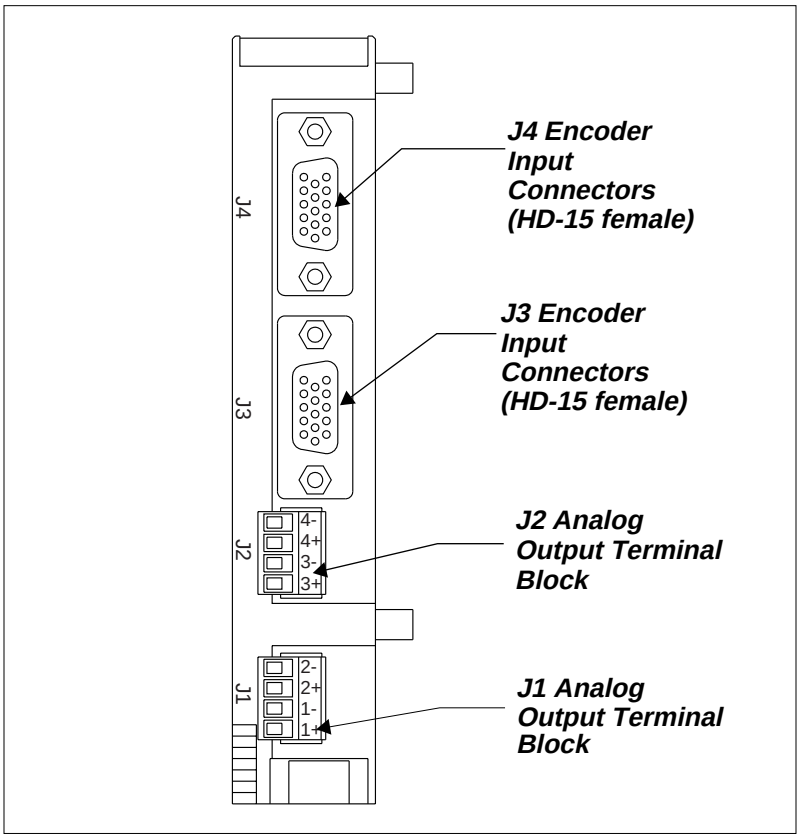


Figure 7.7 PPC-2030 Bottom View

Table 7.22 Model Number

PPC-2030	4 Encoder Input / 4 Analog Output Module

Table 7.23 Environmental Specifications

Storage Temperature	-20 to 70ºC
Operating Temperature	0 to 60ºC
Humidity	10 to 95% non-condensing

Table 7.24 Physical Specifications

Weight	0.62 lbs	0.28 kg
Height	8.0 in.	203 mm
Width	1.5 in.	38 mm
Depth	5.25 in.	133 mm

Table 7.25 Connections

Mounting	DIN rail or panel mount
Terminals	Captive screw cage clamp
Connector	High Density D-sub 15 female contact
Screw Terminal Wire Gauge	24 to 16 AWG
Screw Terminal Torque	0.22 to 0.25 Nm (1.9 to 2.2 in-lb.)

Table 7.26 Power Specifications

Power Requirement	10.8 W typical
Current (@ 12Vdc)	900mA typical @ 25ºC
Current (@ 24Vdc)	450mA typical @ 25ºC
Modules per Processor	4

Table 7.27 Input Specifications

Encoder Inputs	4
Maximum Input Frequency	10 kHz
Max Counts	10,000 counts/sec single phase 32,000 counts/sec quadrature
Sample Rate	250 ms to sample all 4 inputs (4 Hz)
Pulse Input Voltage Range: Single-ended	$3.0\ V < V_{hi} \leq 5.0\ V$ $0.0\ V \leq V_{lo} < 2.0\ V$
Pulse Input Voltage Range: Differential	±14.0 max., 0.0 to 5.0V nominal
Input Current: Single-ended	± 1.0mA
Input Current: Differential	± 3.0mA
Count Range	16 bits
Power for Encoders	5V @ 240mA max.

Table 7.28 Output Specifications

Analog Outputs	4
Isolation	120Vac to power common or ground
Resolution	12 bits
Range (Voltage Mode)	0 to +10V @ 10mA maximum
Accuracy (Voltage Mode)	0.3% of reading ± 0.5% of range at 25°C
Load (Voltage Mode)	≥ 1000 ohm
Range (Current Mode)	0 to 20mA with 8V minimum compliance (400 Ohm load)
Accuracy (Current Mode)	1.5% of reading ± 0.2% of range at 25°C
Output Update Time	0.1 sec.

Table 7.29 Safety and Agency Approvals

UL C-UL	3121-1 Listed, Category II Installation, File # E212113

PPC-2040 Digital I/O Specifications

The PPC-2040 provides 32 digital I/O points. Each may be configured as an input or an output. The count and frequency of changes to the state of the first two inputs are read as analog inputs as well.

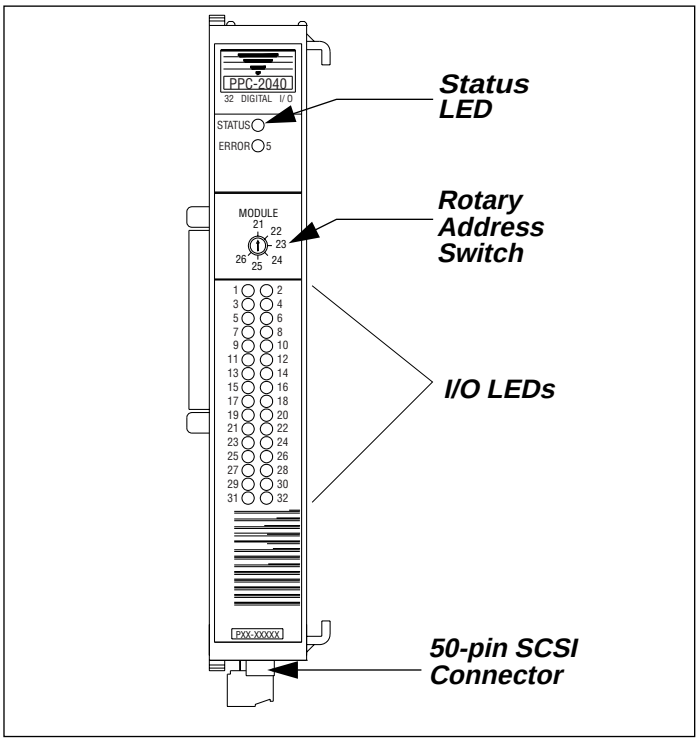


Figure 7.8 PPC-2040 Front View

Table 7.30 Model Number

PPC-2040	Digital I/O

Table 7.31 Environmental Specifications

Storage Temperature	-20 to 70ºC
Operating Temperature	0 to 60ºC
Humidity	10 to 95% non-condensing

Table 7.32 Physical Specifications

Weight	0.82 lbs.	0.37 kg
Height	8.0 in.	203 mm
Width	1.5 in.	38 mm
Depth	5.25 in.	133 mm

Table 7.33 Connections

Connector on Module	50-pin SCSI-2 female
Mounting	DIN rail or panel mount

Table 7.34 Power Specifications

Power Requirement	3.6 W typical
Current @ 12Vdc	300mA typical @ 25ºC
Current @ 24V	150mA typical @ 25ºC
Modules per Processor	6

Table 7.35 Counter/Frequency Specifications

Number	2
Maximum Frequency	10 kHz
Max Counts	10,000 counts/sec. single-phase 32,000 counts/sec. quadrature
Sample Rate	250 ms (4 Hz)
Pulse Input Voltage Range: Single-ended	<0.6 = Low; 3.8V = High
Maximum Current	0.5mA from module with input at 0V
Input Resistance	6 kOhms Min.
Count Range	16 bits

Table 7.36 Digital Input Specifications

Number	32*
Voltage Limiting and Protection	40Vdc
Logic Voltage Levels	<0.6 = Low; 3.8V = High
Maximum Current	0.5mA from processor with input at 0V
Switch Resistance to Pull Low	1 kOhms Maximum
Switch Resistance for High	27 kOhms Minimum

*The PPC-2040 has 32 digital I/O points. Each can be configured as either an input or an output.

Table 7.37 Digital Output Specifications

Number	32*
Maximum Voltage	24Vdc
Maximum Current	150mA sink to common
Off State Leakage Current	<0.010mA up to 30Vdc

*The PPC-2040 has 32 digital I/O points. Each can be configured as either an input or an output.

PPC-205x Analog Out Specifications

The PPC-2050 and PPC-2051 provide eight and four analog outputs, respectively. Each output is configurable as a voltage or current output.

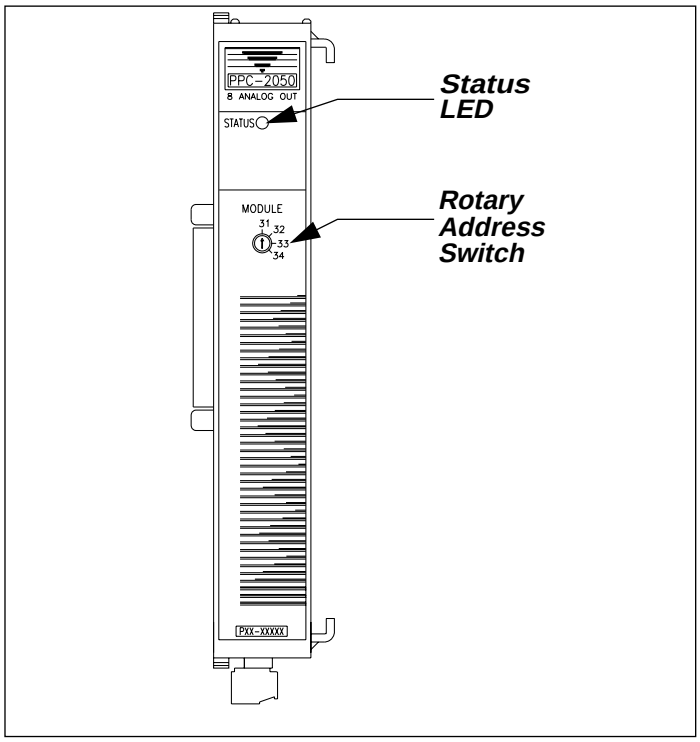


Figure 7.9 PPC-2050 Front View

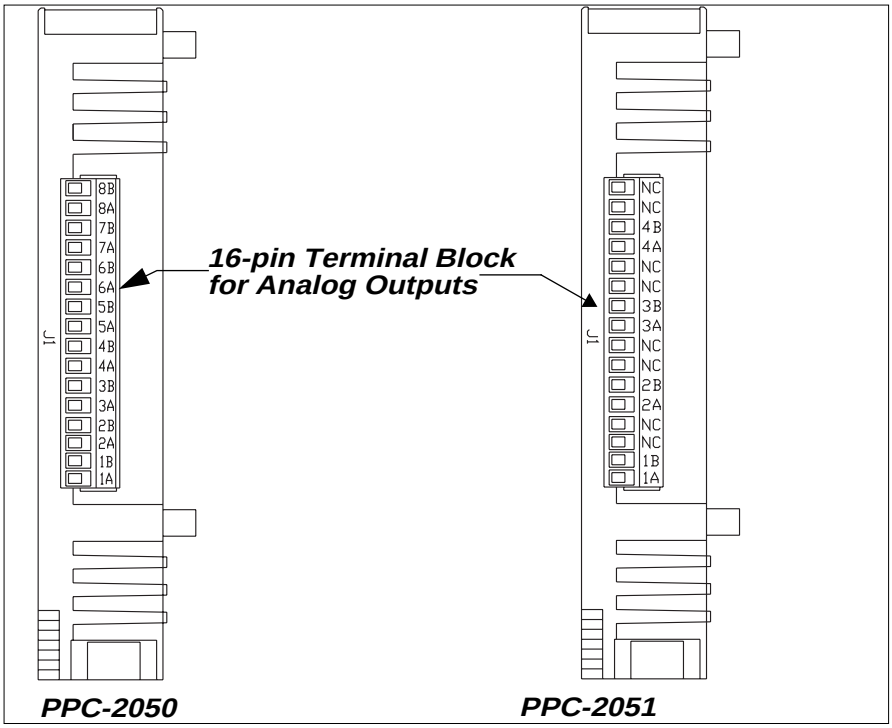


Figure 7.10 PPC-2050 Bottom View

Table 7.38 Model Number

PPC-2050	8 Analog Out
PPC-2051	4 Analog Out

Table 7.39 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
°C Humidity	10 to 95% non-condensing

Table 7.40 Physical Specifications

Weight	0.6 lb.	0.27 kg
Height	8.0 in.	203 mm
Width	1.5 in.	38 mm
Depth	5.25 in.	133 mm

Table 7.41 Connections

Wire Gauge	24 to 16 AWG
Screw Terminal Torque	0.22 to 0.25 Nm (1.9 to 2.2 in-lb)
Mounting	DIN rail or panel mount

Table 7.42 Power Specifications PPC-2050

Power Requirement	9.6 W typical
Current @ 12Vdc	800mA typical @ 25ºC
Current @ 24Vdc	400mA typical @ 25ºC

Table 7.43 Power Specifications PPC-2051

Power Requirement	6 W typical
Current @ 12Vdc	500mA typical @ 25ºC
Current @ 24Vdc	250mA typical @ 25ºC

Table 7.44 Output Specifications

Number	8 (PPC-2050) 4 (PPC-2051)
Configuration	4 individually isolated (PPC-2051) 4 isolated pairs: 1&2, 3&4, 5&6, 7&8 (PPC-2050)
Isolation	120Vac to power common and earth ground 120Vac output-to-output (PPC-2051) 120Vac output pair-to-output pair. Paired outputs share power supply. (PPC-2050)
Voltage Range	0 to 10Vdc @ 10mA maximum
Current Range	0 to 20mA with 8V minimum compliance (400 Ohm load)
Voltage Accuracy	± 0.5% of range at 25ºC
Current Accuracy	± 0.8% of range at 25°C
Output Update Time	0.1 second

PPC-206x Digital Output Specifications

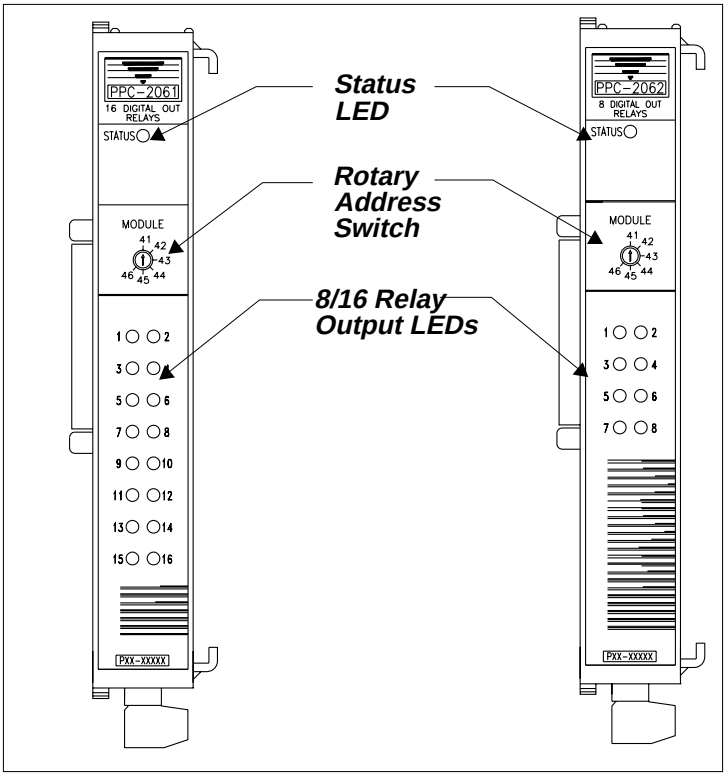


Figure 7.11 PPC-206x Front View

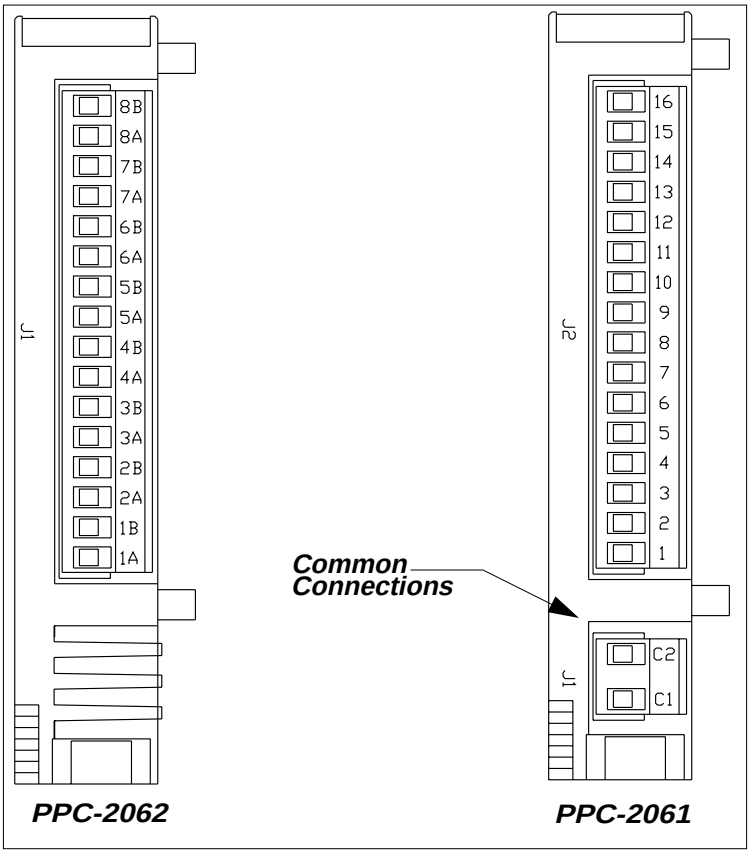


Figure 7.12 PPC-206x Bottom View

Table 7.45 Model Number

PPC-2061	16 Digital Out Relay
PPC-2062	8 Digital Out Relay

Table 7.46 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
Humidity	10 to 95% non-condensing

Table 7.47 Connections

Screw Terminal Wire Gauge	24 to 12 AWG
Screw Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in-lb.)
Mounting	DIN rail or panel mount

Table 7.48 Physical Specifications

Weight	0.50 lbs.	0.27 kg
Height	8.0 in.	203 mm
Width	1.5 in.	38 mm
Depth	5.25 in.	133 mm

Table 7.49 Power Specifications

Power Requirement	3 W typical
Current (@ 12Vdc)	250mA typical @ 25°C
Current (@ 24Vdc)	125mA typical @ 25°C
Modules per Processor	6

Table 7.50 Output Specifications

Relay Outputs	8 (PPC-2062) 16 (PPC-2061)
Relay Type	Form A (SPST NO)
Isolation	240Vac to power common or ground
Contact Arrangement	open in power off, fault or inactive condition
Maximum Load Current	2A (PPC-2062) 1A up to 5A per common (PPC-2061)
Contact Voltage Rating	240Vac, 30Vdc

PPC-207x Digital In Specifications

The PPC-207x modules provide 8 or 16 digital inputs. The 2070 and 2071 accept 120Vac signals. The 2072 and 2073 accept 24Vac or 24Vdc signals.

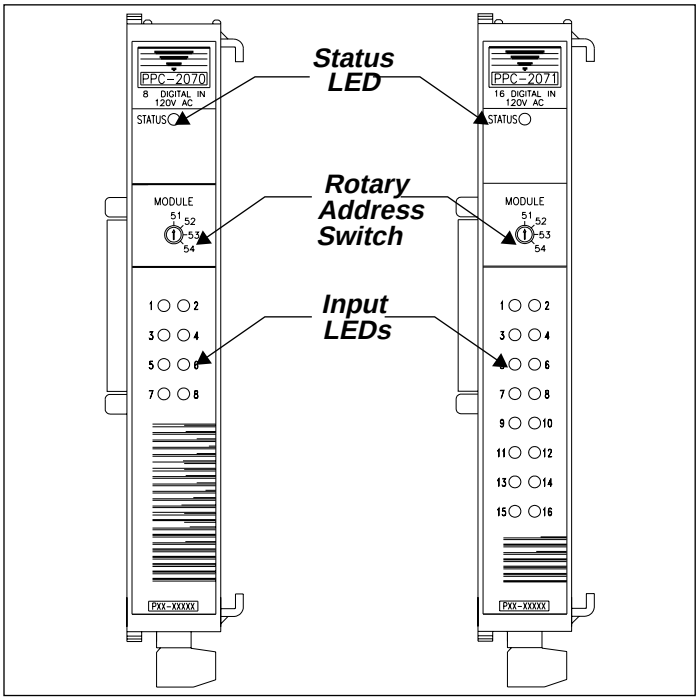


Figure 7.13 PPC-2070, PPC-2071 Front Views

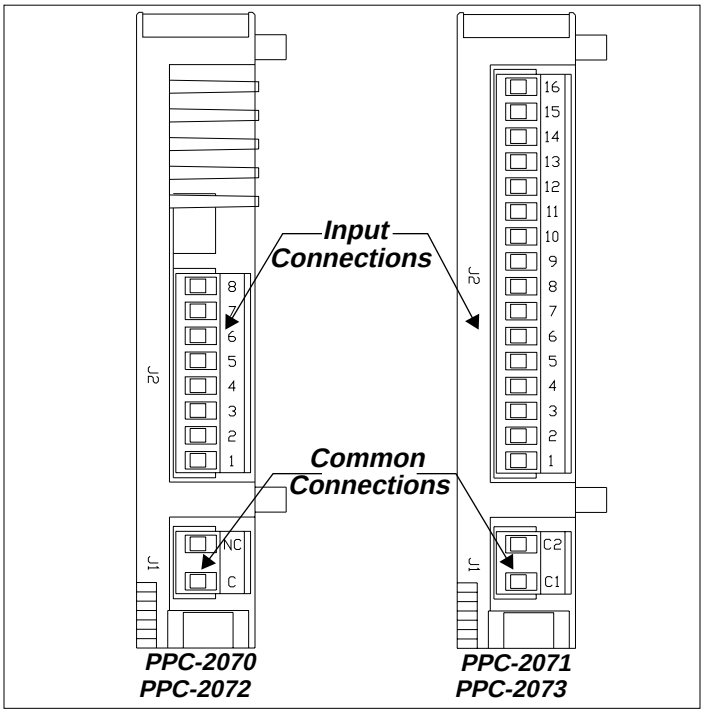


Figure 7.14 PPC-207x Bottom Views

Table 7.51 Model Number

PPC-2070	8 Digital In 120Vac
PPC-2071	16 Digital In 120Vac
PPC-2072	8 Digital In 24Vac/dc
PPC-2073	16 Digital In 24Vac/dc

Table 7.52 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
Humidity	10 to 95% non-condensing

Table 7.53 Physical Specifications

Weight	0.52 lbs	0.24 kg
Height	8.0 in.	203 mm
Width	1.5 in.	38 mm
Depth	5.25 in.	133 mm

Table 7.54 Connections

Wire Gauge	24 to 12 AWG
Screw Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in-lb.)
Mounting	DIN rail or panel mount

Table 7.55 Power Specifications

Power Requirement	1.2 W typical
Current (@ 12Vdc)	100mA typical @ 25°C
Current (@ 24Vdc)	50mA typical @ 25°C
Modules per Processor	4

Table 7.56 Digital Input Specifications

Number	8 (PPC-2070, and 2072) 16 (PPC-2071 and 2073)
Input Voltage Range	70-120Vac ±10% (PPC-2070, 2071) 12-24Vac/dc ±10% (PPC-2072,2073)
Logic Voltage Levels	120Vac High > 70V Low < 20V 24Vac/dc High > 10V Low < 3V
Input Response Time	32 ms (PPC-2070, 2071) 32 ms (12-24Vdc PPC-2072,2073) 32 ms (20-24Vac PPC-2072,2073) 64 ms (12-20Vac PPC-2072,2073)
Input Impedance	77 kOhms (PPC-2070, 2071) 16.9 kOhms (PPC-2072, 2073)
Input Current	1.5mA (typical) @ 120Vac or 24Vac/dc
Switch Resistance to Pull Low	1 kOhms Maximum
Switch Resistance for High	27 kOhms Minimum

PPC-AITB-1 Analog Input Terminal Block Specifications

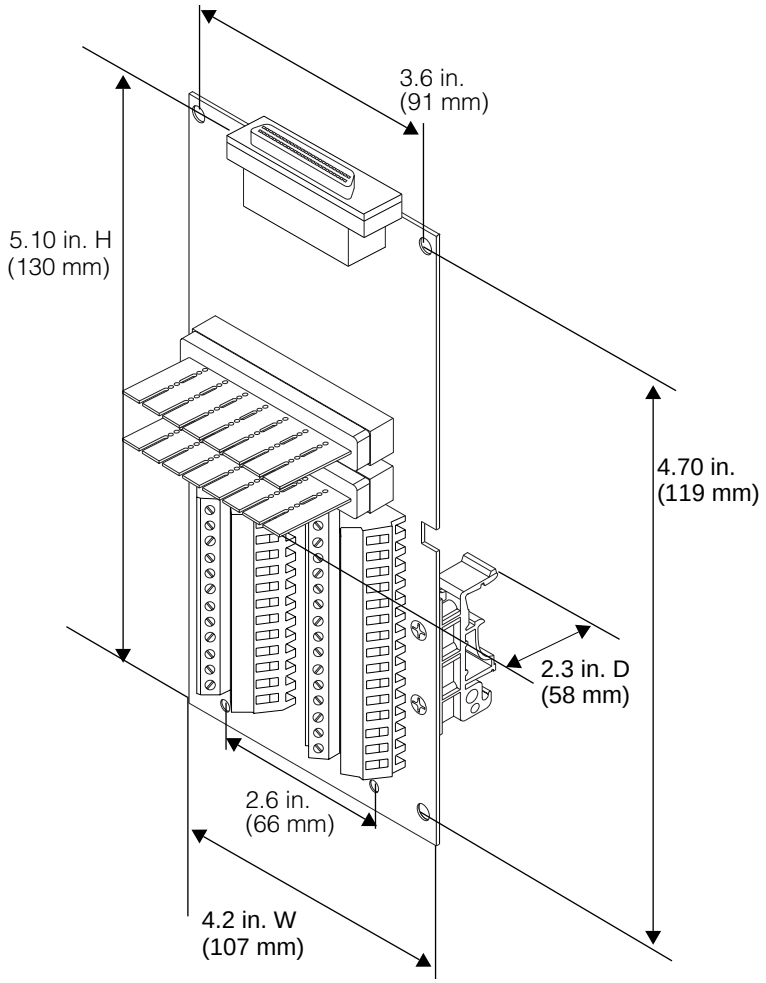


Figure 7.15 PPC-AITB-1

Table 7.57 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
Humidity	10 to 95% non-condensing

Table 7.58 Physical Specifications

Weight	0.5 lbs	0.22 kg
Height	5.1 in.	130 mm
Width	4.2 in.	107 mm
Depth	2.3 in.	58 mm

Table 7.59 Connections

Screw Terminal Wire Gauge	24 to 12 AWG
Screw Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in-lb.)
Connector on Board	SCSI-2 female
Terminals	Captive screw cage clamp
Mounting	DIN rail or panel mount

Table 7.60 PPC-AITB with Straight SCSI

Height	7.1 in.	180 mm
Width	4.2 in.	107 mm
Depth	2.3 in.	58 mm

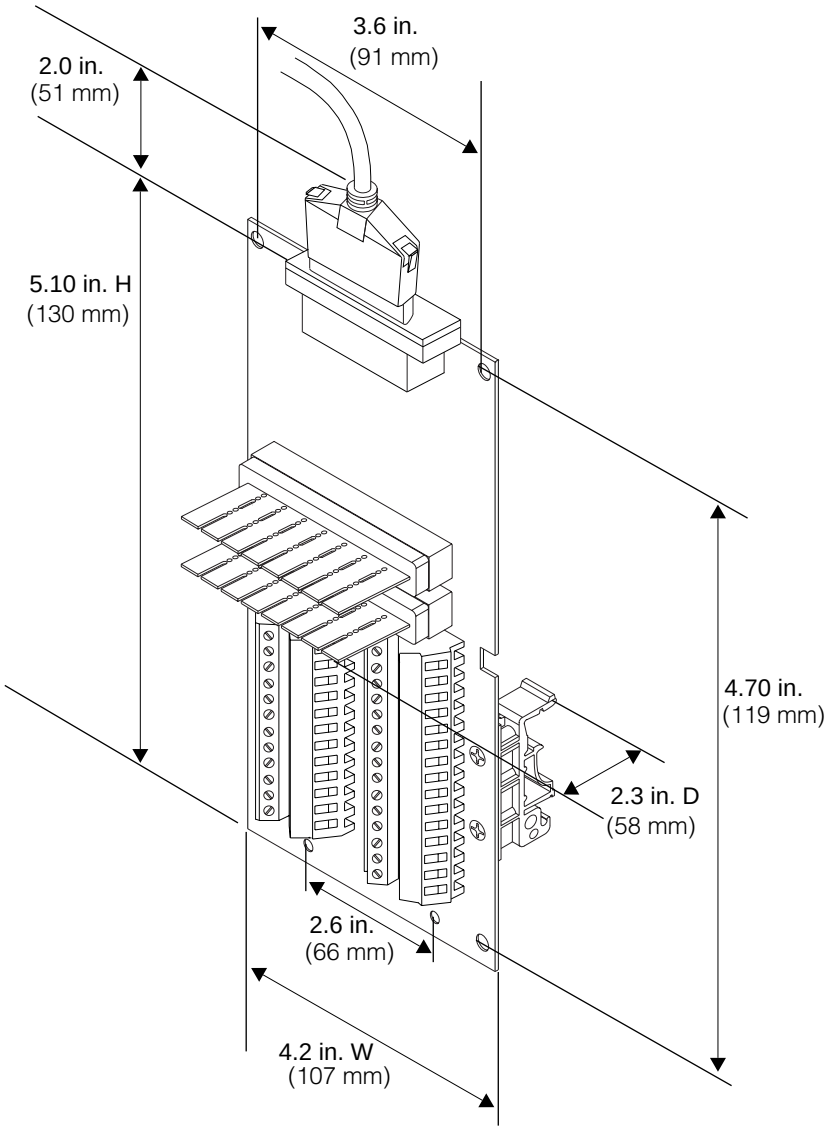


Figure 7.16 PPC-AITB Dimensions with Straight SCSI Cable

Four factory-configured input sensor keys plug into the AITB and accommodate various input types. The following table describes usage for the various keys:

Table 7.61 Sensor Key Cards

Key Type	Key Description	Color Code
PPC-KEY-01	Adapts AITB for: thermocouples (differential or single-ended) Linear voltages (differential or single-ended) 4-wire RTDs (differential)	None
PPC-KEY-02	adapts AITB for 0-20mA linear current (differential)	Blue
PPC-KEY-03	adapts AITB for 0-20mA linear current (single-ended)	Black
PPC-KEY-04	adapts AITB for 2-wire RTDs (differential) or 3-wire RTDs (differential)	Red

PPC-EITB-1 Encoder Input Terminal Block Specifications

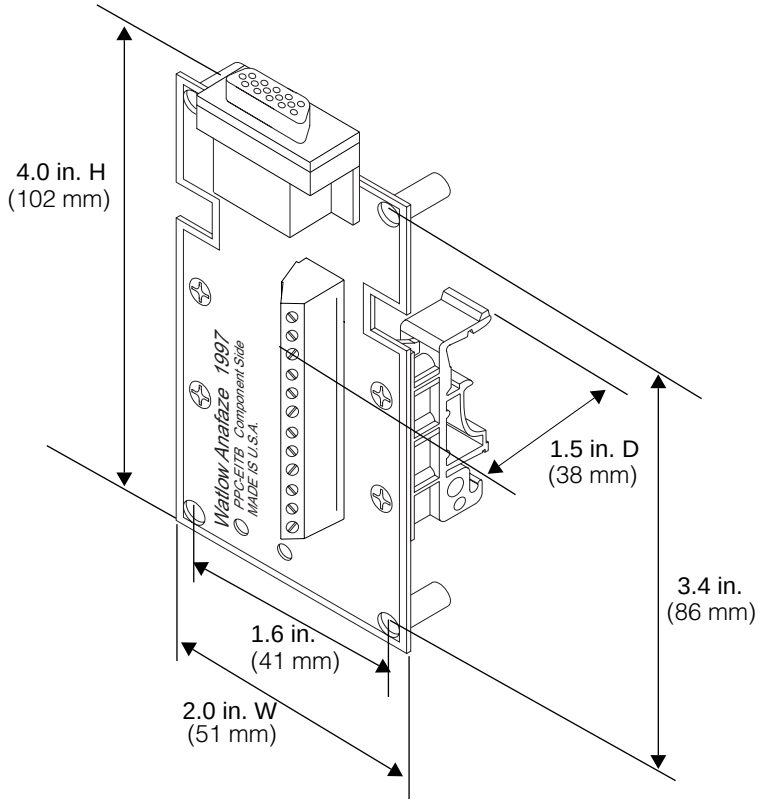


Figure 7.17 PPC-EITB-1

Table 7.62 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
Humidity	10 to 95% non-condensing

Table 7.63 Physical Specifications

Weight	0.10 lbs	0.05 kg
Height	4.0 in.	102 mm
Width	2.0 in.	51 mm
Depth	1.5 in.	38 mm
Mounting	DIN rail or panel mount	

Table 7.64 Connections

Screw Terminal Wire Gauge	24 to 12 AWG
Screw Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in-lb.)
Connector on Board	High density D-sub 15-pin female connection
Terminals	Captive screw cage clamp
Number of Screw Terminals	12

Table 7.65 PPC-EITB with HD-Type Cable

Height	4.0 in.	102 mm
Width	2.0 in.	51 mm
Depth	2.2 in.	56 mm

Table 7.66 Safety and Agency Approvals

UL C-UL	3121-1 Listed, Category II Installation, File # E212113

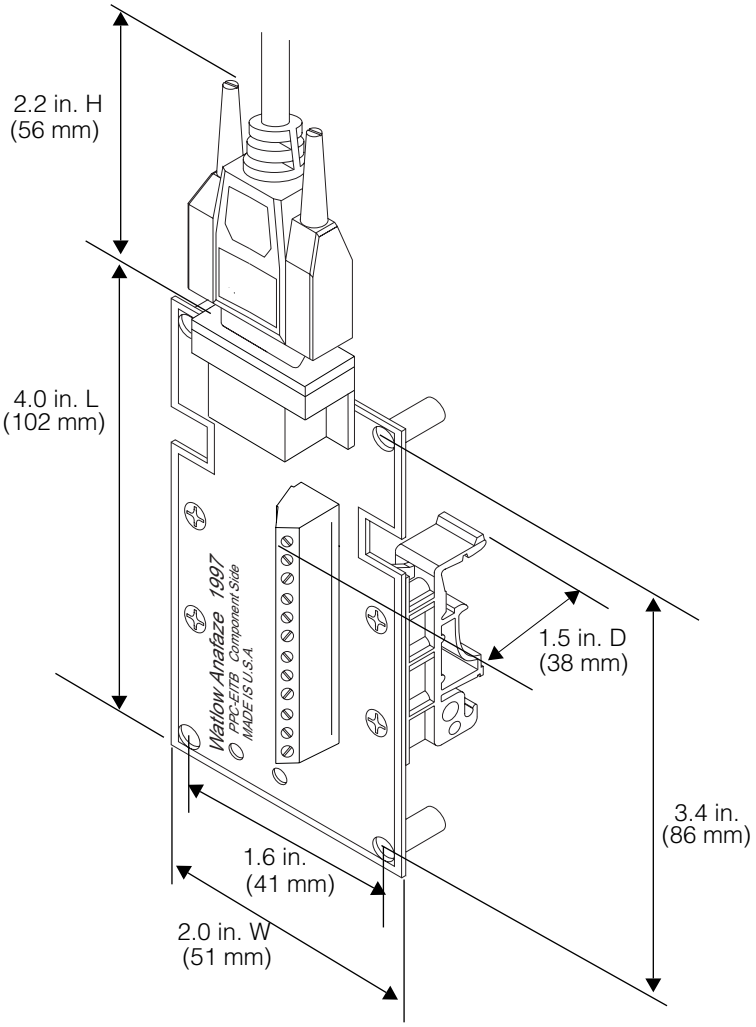


Figure 7.18 PPC-EITB Dimensions with HD-Type Cable

PPC-TB50-SCSI, 50-Pin Specifications

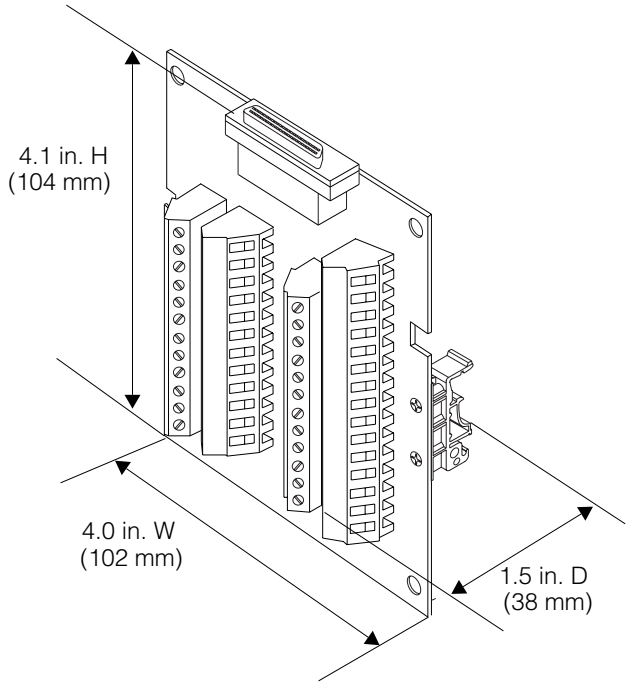


Figure 7.19 PPC-TB50-SCSI Dimensions

Table 7.67 Environmental Specifications

Storage Temperature	-20 to 70°C
Operating Temperature	0 to 60°C
Humidity	10 to 95% non-condensing

Table 7.68 Physical Specifications

Weight	0.32 lbs.	0.14 kg
Height	4.1 in.	104 mm
Width	4.0 in.	102 mm
Depth	1.45 in.	37 mm

Table 7.69 Connections

Screw Terminal Wire Gauge	24 to 12 AWG
Screw Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in-lb.)
Connector on Board	SCSI-2 female
Terminals	Captive screw cage clamp
Mounting	DIN rail or panel mount

Table 7.70 PPC-TB50-SCSI with Straight SCSI

Height	6.4 in.	163 mm
Width	4.0 in.	102 mm
Depth	1.45 in.	37 mm

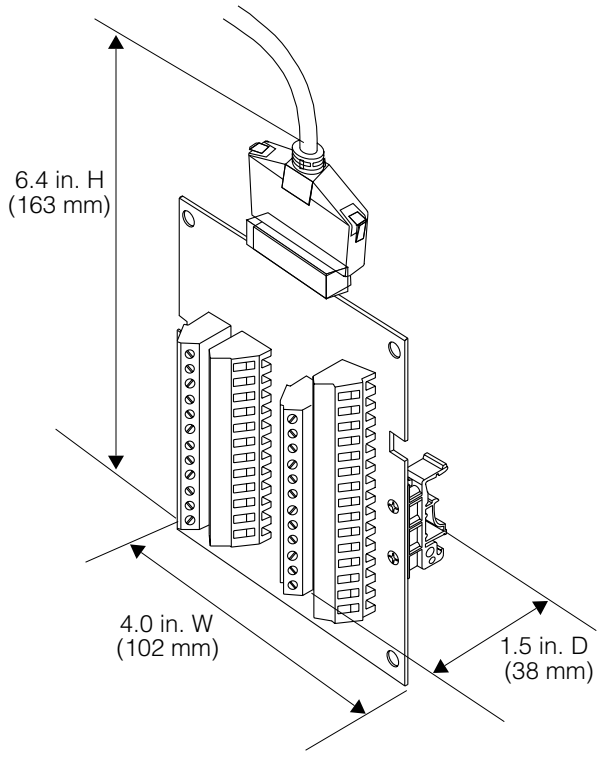


Figure 7.20 PPC-TB50-SCSI Dimensions with Straight SCSI Cable

Table 7.71 PPC-TB50-SCSI with Right Angle SCSI

Height	5.4 in.	137 mm
Width	4.0 in.	102 mm
Depth	1.5 in.	3.7 mm

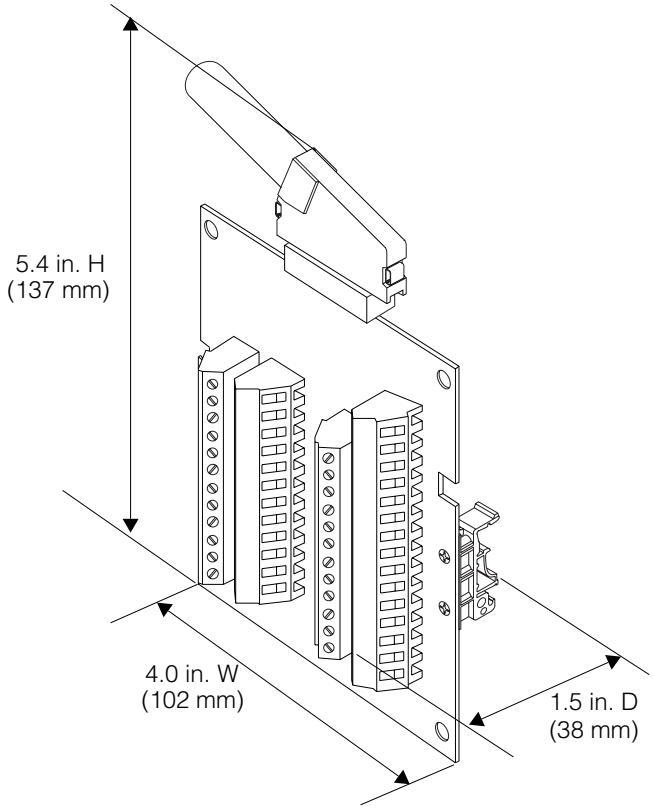


Figure 7.21 PPC-TB50-SCSI Dimensions with Right-Angle SCSI Cable

PPC-IPS-2 International Power Supply Specifications

Watlow Anafaze offers a dual output power supply for PPC-2000 systems. The PPC-IPS-2 accepts worldwide AC voltages and outputs 5 and 24Vdc

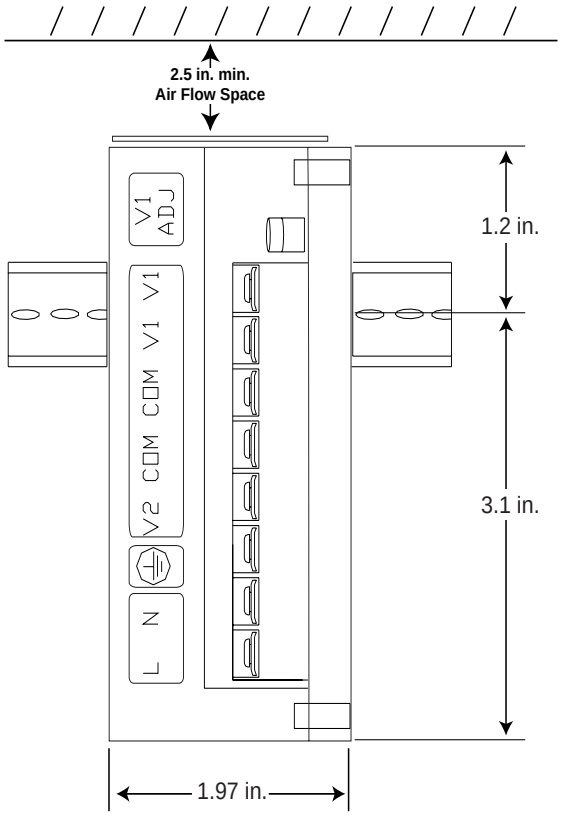


Figure 7.22 PPC-IPS-2

Table 7.72 Environmental Specifications

Storage Temperature	-20°C to 70°C
Operation Temperature	0°C to 60°C
Humidity Conditions	20 to 90% non-condensing

Table 7.73 Physical Specifications

Weight	1.4 lbs.	0.64 kg
Height	7.8"	198 mm
Width	1.9"	48 mm
Depth	4.3"	109 mm
Mounting	Panel mount	

Table 7.74 Dimensions with Din Rail Bracket

Height	4.5 in.	114 mm
Width	1.9 in.	48 mm
Depth	8.5 in.	216 mm

Table 7.75 Power Specifications

Input	88 to 132Vac (115V Range) 176 to 264Vac (230V Range)
Output	V1: +5Vdc @ 6A V2: +24Vdc @ 4A
Input Frequency	47 to 440 Hz
Peak Current Output	9A @ 5Vdc 6A @ 24Vdc

Table 7.76 Connections

Connector Type	Spade
Output Screw Terminal Wire Gauge	24 to 12 AWG
Screw Terminal Torque	0.5 to 0.6 Nm (4.4 to 5.3 in-lb.)

Table 7.77 Safety and Agency Approvals

UL C-UL	UL 1012, UL 1950
CE	EN 60950
CE EMC	EN 55022

SDAC Specifications

Watlow Anafaze offers a Serial DAC for precision open-loop control. The SDAC is jumper selectable for a 0-10Vdc or 4-20mA output. Multiple SDAC modules can be used with one PPC system. The SDAC carries a CE mark.

Table 7.78 Environmental Specifications

Storage Temperature	-20 to 60°C
Operating Temperature	0 to 70°C 50
Humidity	10 to 95% non-condensing

Table 7.79 Physical Specifications

Weight	0.76 lbs	0.34 kg
Height	5.4 in.	137 mm
Width	3.6 in.	91 mm
Length	1.75 in.	44 mm

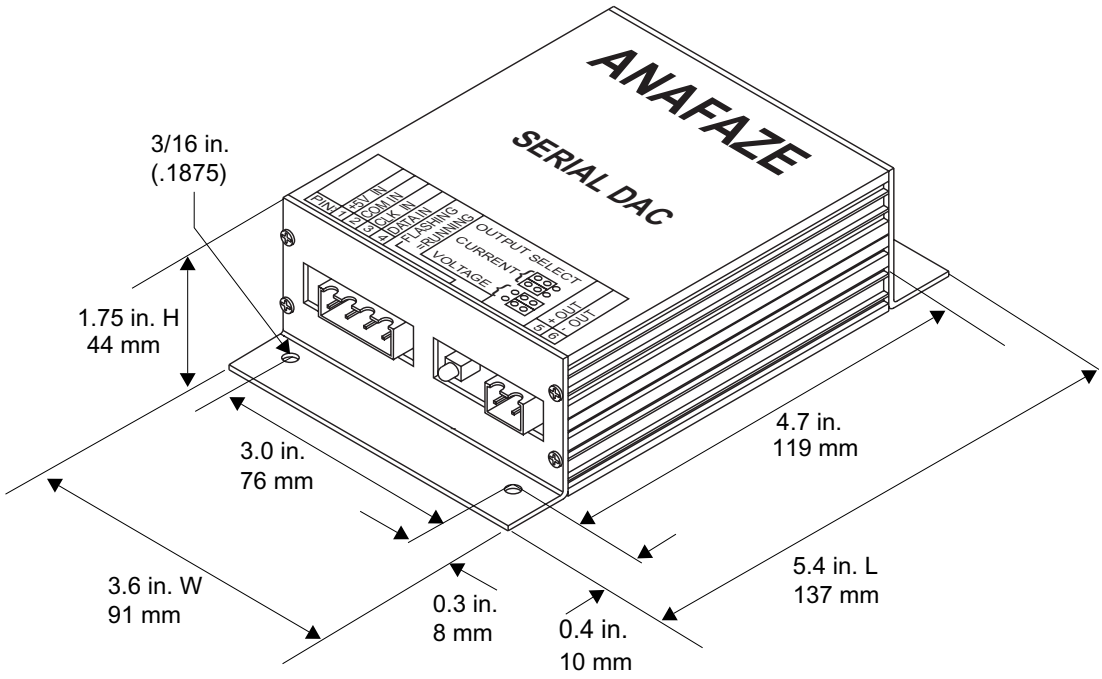


Figure 7.23 SDAC Dimensions

Table 7.80 Safety and Agency Approvals

UL C-UL	UL 916, File E177240
CE EMC	Directive 89/336/EEC

Inputs

The SDAC requires a proprietary serial data signal and the clock signal from the PPC-2010 via the TB50. Any control output can be configured to provide the data signal. The SDAC also requires a 5Vdc power input.

Table 7.81 Inputs

Data	4mA maximum to dc COM Open collector or HC CMOS logic levels
Clock	0.5mA max to dc COM Open collector or HC CMOS logic levels
Maximum Clock Rate	10 kHz (333 updates/second)

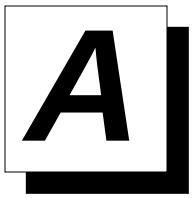
Table 7.82 Power Requirements

Voltage	4.75 to 5.25Vdc @ 300mA max
Current	210mA typical @ 20Vdc out

Analog Outputs

Table 7.83 Analog Output Specifications

Absolute Maximum Common Mode Voltage	Measured between output pins and controller common: 1000V
Resolution	15 bits (plus polarity bit for voltage outputs) (0.305mV for 10V output range) (0.00061mA for 20mA output range)
Accuracy (calibrated for voltage output)	For voltage output: ± 0.005V (0.05% at full scale) For current output: +/ 0.1mA (0.5% at full scale)
Temperature coefficient	440 ppm/ °C typical
Isolation Breakdown Voltage	1000V between input power and signals
Current	0-20mA (500 Ohm load max.)
Voltage	0-10Vdc with 10mA source capability
Output Response Time	1 ms typical
Update Rate	Once per controller A/D cycle nominal. Twice per second maximum for 60 Hz clock rate. Output changes are step changes due to the fast time constant. All SDAC loop outputs are updated at the same time.



Appendix A: Modbus Protocol

Watlow Anafaze offers a modbus driver (.DLL) for use with user-written Windows-based software applications that communicate with the PPC-2000. Using that driver makes it unnecessary for the programmer to understand and implement the modbus protocol.

PPC-2000 serial communications use the Modbus RTU protocol. This protocol defines the message structure for all communication packets. The protocol is the same for both RS-232 and RS-485 serial interfaces. Modbus ASCII is not supported.

Up to 32 PPCs may be connected on a network.

Controllers communicate using a master-slave model, in which only one device (the master) can initiate transactions (called “queries”). The other devices (slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host PCs and operator panels. The PPC-2000 is a slave device.

The master can address individual slaves, or initiate a broadcast message to all slaves. Slaves return a message (called a “response”) to queries that are addressed to them individually. Responses are not returned to broadcast queries from the master.

The Modbus protocol establishes the format for the master’s query by placing into it the device (or broadcast) address, a function code defining the requested action, any data to be sent, and an error-checking field. The slave’s response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and an error-checking field. If an error occurred in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as its response.

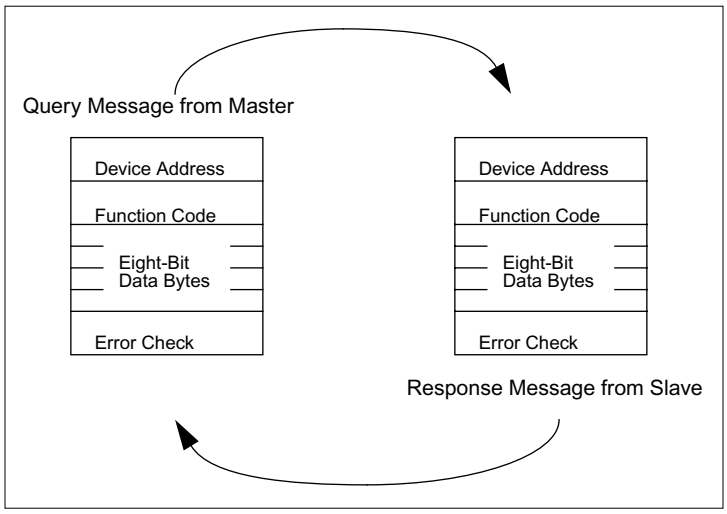


Figure A.1 Query—Response Cycle

Query

The function code in the query tells the addressed slave device what kind of action to perform. The data bytes contain any additional information that the slave will need to perform the function. For example, function code 03 will query the slave to read holding registers and respond with their contents. The data field must contain the information telling the slave which register to start at and how many registers to read. The error check field provides a method for the slave to validate the integrity of the message contents.

Response

If the slave makes a normal response, the function code in the response is an echo of the function code in the query. The data bytes contain the data collected by the slave, such as register values or status. If an error occurs, the function code is modified to indicate that the response is an error response, and the data bytes contain a code that describes the error. The error check field allows the master to confirm that the message contents are valid.

Modbus ASCII and RTU Modes

Modbus protocol specifies two distinct modes: ASCII and RTU. While the PPC-2000 only supports RTU, it is important to understand the differences. Typically, ASCII is used for simple communication tasks or diagnostics while RTU is used where a more robust and efficient protocol is required.

The mode determines how messages are framed and coded. In ASCII, each character in a message string is composed of a hexadecimal character which is correlated to an ASCII character. So for example, an ASCII message string contains the value of a process variable, 5500 (550.0 degrees). 5500 in an ASCII string is composed of 4 bytes, 35 35 30 30. 35 and 30 in hexadecimal equate to the characters "5" and "0" in the ASCII table respectively.

In RTU mode, the actual value is embedded in a message string. There is no translation to ASCII characters. This results in more compact message strings and efficient serial communications. The value 5500 in an RTU string is composed of its hexadecimal equivalent which is only 2 bytes, 15 7C.

Many host devices can communicate in either ASCII or RTU mode. However, it should be noted that some PLCs can only be an ASCII host.

Message Framing

Messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network (shown as T1-T2-T3-T4 in the figure below). The first field then transmitted is the device address.

Networked controllers monitor the network bus continuously, including during the silent intervals. When the first field (the address field) is received, each device decodes it to find out if it is the addressed device.

Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.

Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will set an error, as the value in the final CRC field will not be valid for the combined messages. An example message frame is shown in *Table A.1*.

Table A.1 Example Message Frame

Start	Address	Function	Data	CRC Check	End
T1-T2-T3-T4	8 Bits	8 Bits	n X 8 Bits	16 Bits	T1-T2-T3-T4

Address Field

The address field of a message frame contains eight bits. Valid slave device addresses are in the range of 0-247 decimal. The individual slave devices are assigned addresses in the range of 1-247. Address 0 is reserved for broadcast messages. The PPC controller currently supports only 32 devices. A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.

Function Field

The function code field of a message frame contains eight bits. Valid codes are in the range of 1-255 decimal. Not all these codes are applicable to PPC controllers. Current codes are described in *Function Codes on page 276*.

When a message is sent from a master to a slave device, the function code field tells the slave what kind of action to perform. Examples are to read the On/Off states of a block of digital inputs or outputs; to read the data contents of a block of registers; to read the diagnostic status of a controller.

When the slave responds to the master, it uses the function code field to indicate either a normal (error-free) response or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most significant bit set to a logic 1.

For example, a message from the master to slave to read a block of holding registers would have the following function code:

0000 0011 Hexadecimal 03

If the slave device takes the requested action without error, it returns the same code in its response. If an exception occurs, it returns:

1000 0011 Hexadecimal 83

In addition to its modification of the function code for an exception response, the slave places a unique code into the data field of the response message. This tells the master what kind of error occurred, or the reason for the exception.

The master device's application program has the responsibility of handling exception responses. Typical processes are to post subsequent retries of the message, to try diagnostic messages to the slave, and to notify operators.

Data Field

The contents of the data field varies depending on whether messages originate from a master or slave. Data fields in slave messages consist of hexadecimal values.

Data fields of master messages contain additional information which the slave must use to take the action defined by the function code. This can include items like digital and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.

For example, if the master requests a slave to read a group of holding registers (function code 03), the data field specifies the starting register and how many registers are to be read.

If no error occurs, the data field of a response from a slave to a master contained the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken.

The data field can be nonexistent (of zero length) in certain kinds of messages, where the function code alone specifies the action.

Error Checking Field

The error checking field contains a 16-bit value implemented as two 8-bit bytes. The error check value is the result of a Cyclical Redundancy Check calculation performed on the message contents.

The CRC field is appended to the message as the last field in the message. When this is done, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte to be sent in the message.

Field Format

When messages are transmitted on standard Modbus serial networks, each character or byte is sent in this order (left to right):

Least Significant Bit (LSB).....Most Significant Bit (MSB)

The bit sequence is:

- With Parity Checking

Start	1	2	3	4	5	6	7	8	Parity	Stop

- Without Parity Checking

Start	1	2	3	4	5	6	7	8	Stop	Stop

Error Checking Methods

Modbus RTU use two kinds of error checking:

- Parity checking
- Frame checking (CRC)

Parity checking can be optionally applied to each character, while the frame checking is applied to the entire message. Both the character check and message frame check are generated in the master device and applied to the message contents before transmission. The slave device checks each character and the entire message frame during receipt.

The master is configured by the user to wait for a predetermined time-out interval before aborting the transaction. This interval is set to be long enough for any slave to respond normally. If the slave detects a transmission error, the message will not be acted upon. The slave will not construct a response to the master. Thus the time-out will expire and allow the master's program to handle the error. Note that a message addressed to a nonexistent slave device will also cause a time-out.

Parity Checking

Users can configure controllers for Even or Odd Parity checking, or for No Parity checking. This will determine how the parity will be set in each character.

If either Even or Odd Parity is specified, the quantity of 1 bits will be counted in the data portion of each character (8 bits). The parity bit will then be set to a 0 or 1 to result in an Even or Odd total of 1 bits.

For example, these eight data bits are contained in an RTU character frame:

1100 0101

The total quantity of 1 bits in the frame is four. If Even Parity is used, the frame's parity bit will be a 0, making the total quantity of 1 bits still an even number (four). If Odd Parity is used, the parity bit will be a 1, making an odd quantity (five).

When the message is transmitted, the parity bit is calculated and applied to the frame of each character. The receiving device counts the quantity of 1 bits and sets an error if they are not the same as configured for that device (all devices on the Modbus network must be configured to use the same parity check method).

Note that parity checking can only detect an error if an odd number of bits are picked up or dropped in a character frame during transmission. For example, if Odd Parity checking is used, and two 1 bits are dropped from a character containing three 1 bits, the result is still an odd count of 1 bits.

If No Parity checking is specified, no parity bit is transmitted and no parity check can be made. An additional stop bit is transmitted to fill out the character frame.

CRC Checking

All messages include an error-checking field that is based on a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message.

The CRC field is two bytes, containing a 16-bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

The CRC is started by first pre-loading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit if one is used, do not apply to the CRC.

During generation of the CRC, each 8-bit character is exclusive ORed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a 0 filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value (A001 hex). If the LSB was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last shift, the next 8-bit byte is exclusive ORed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the bytes of the message have been applied, is the CRC value.

Function Codes

The listing below shows the function codes supported by the PPC controllers. Codes are listed in decimal.

Table A.2 Function Codes

Code Decimal	Name
01	Read Coil Status
02	Read Input Status
03	Read Holding Registers
04	Read Input Registers
05	Force Single Coil
06	Preset Single Register
08	Diagnostics
15	Force Multiple Coils
16	Preset Multiple Registers

Read Coil Status 01

Reads the On/Off status of discrete outputs (0X references, coils) in the slave. Broadcast is not supported.

Read Input Status 02

Reads the On/Off status of discrete inputs (1X references) in the slave. Broadcast is not supported.

Read Holding Registers 03

Reads the binary contents of holding registers (4X references) in the slave. Broadcast is not supported.

Read Input Registers 04

Reads the binary contents of input registers (3X references) in the slave. Broadcast is not supported.

Force Single Coil 05

Forces a single coil (0X reference) to either On or OFF. When broadcast, the function forces the same coil reference in all attached slaves.

Preset Single Register 06

Presets a value into a single holding register (4X reference). When broadcast, the function presets the same register reference in all attached slaves.

Diagnostics 08

This function provides a series of tests for checking the communication system between the master and slave, or for checking various internal error conditions within the slave. Broadcast is not supported.

The function uses a two-byte Sub-function code field in the query to define the type of test to be performed. The slave echoes both the function code and sub-function code in a normal response.

Most of the diagnostic queries use a two-byte data field to send diagnostic data or control information to the slave. Some of the diagnostics cause data to be returned from the slave in a data field of a normal response.

Force Multiple Coils 15

Forces each coil (0X reference) in a sequence of coils to either ON or OFF. When broadcast, the function forces the same coil references in all attached slaves.

Preset Multiple Registers 16

Presets values into the sequence of holding registers (4X references). When broadcast, the function presets the same register references an all attached slaves.

The following sections detail the *Diagnostics (08)* subfunctions.

Diagnostics Subfunction -- Return Query Data 00

The data passed in the query data field is to be returned (looped back) in the response. The entire response message should be identical to the query.

Subfunction (Response)	***Data Field (Query)***	***Data Field***
00 00	Any	Echo Query Data

Diagnostics Subfunction -- Restart Communications Option 01

The slave's peripheral port is to be initialized and restarted, and all of its communications event counters are to be cleared. If the port is currently in Listen Only Mode, no response is returned. This function is the only one that brings the port out of Listen Only Mode. If the port is not currently in Listen Only Mode, a normal response is returned. This occurs before the restart is executed.

Subfunction (Response)	***Data Field (Query)***	***Data Field***
00 01	00 00	Echo Query Data
00 01	FF 00	Echo Query Data

Diagnostics Subfunction -- Return Diagnostic Register 02

The contents of the slave's 16-bit diagnostic register are returned in the response.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 02	00 00	Diag. Register Contents

Diagnostics Subfunction -- Force Listen Only Mode 04

Forces the addressed slave to its Listen Only Mode for Modbus communications. This isolates it from the other devices on the network, allowing them to continue communicating without interruption from the addressed slave. No response is returned.

When the slave enters its Listen Only Mode, all active communication controls are turned off. The ready watchdog timer is allowed to expire, locking the controls off. While in this mode, any Modbus messages addressed to the salve or broadcast are monitored, but no actions will be taken and no responses will be sent.

The only function that will be processed after the mode is entered will be the Restart Communications Option function (function code 8, subfunction 1).

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 04	00 00	No Response Returned

Diagnostics Subfunction -- Clear Counters 10 (0A Hex)

Clears all Communication Event counters. Counters are also cleared upon power-up.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 0A	00 00	Echo Query Data

Diagnostics Subfunction -- Return Bus Message Count 11 (0B Hex)

The response data field returns the quantity of messages that the slave has detected on the communications system since its last restart, clear counters operations, or power-up.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 0B	00 00	Total Message Count

Diagnostics Subfunction -- Return Bus Communication Error Count 12 (0C Hex)

The response data field returns the quantity of CRC errors encountered by the slave since its last restart, clear counters operation, or power-up.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 0C	00 00	CRC Error Count

Diagnostics Subfunction -- Return Bus Exception Error Count 13 (0D Hex)

The response data field returns the quantity of Modbus exception responses returned by the slave since its last restart, clear counters operation, or power-up.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 0D	00 00	Exception Error Count

Diagnostics Subfunction -- 14 (0E Hex) Return Slave Message Count

The response data field returns the quantity of messages addressed to the slave, or broadcast, that the slave has processed since its last restart, clear counters operation, or power-up.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 0E	00 00	Slave Message Count

Diagnostics Subfunction -- Return Slave No Response Count 15 (0F Hex)

The response data field returns the quantity of messages addressed to the slave for which it returned a no response (neither a normal response nor an exception response), since its last restart, clear counters operation, or power-up.

Subfunction (Response)	*Data Field (Query)*	*Data Field*
00 0F	00 00	Slave No Response Count

Examples

Read Examples

The data read must be sequentially located. When reading a coil rather than a register, the address must be offset by the location of the bit to read. *Table A.3* shows the query and *Table A.4* shows the response:

Table A.3 Sample Packet for Host Query

Example	Slave Address	Function	Start Address High	Start Address Low	Number of Points High	Number of Points Low	CRC	
Reading PV of loop 2 controller 1 (single point read)	01	04	0B	B9	00	01	E2	0B
Reading loops 4 & 5 (primary) output% of controller 3 (multipoint read)	03	03	18	9F	00	02	F3	67
Reading digital input 4 to 13, controller 1 (input status read)	01	01	0B	BB	00	10	4F	C7

Table A.4 Sample Packet for Slave Response

Example	Slave Address	Function	Byte Count	Data1 High	Data1 Low	Data2 High	Data2 Low	CRC	
Reading PV of loop 2 (1600), controller 1 (single point read)	01	04	02	06	40			BB	60
Reading loops 4 & 5 (primary) output% (50%, 60%), of controller 3	03	03	04	01	F4	02	58	99	67
Reading digital input 4 to 13, controller 1 (input status read)	01	01	02	08	00			BE	3C

Write Examples

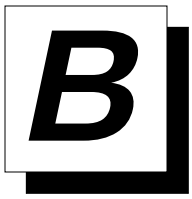
The data written is echoed back to the controller. The following table displays information for sample packet for host transmission. *Table A.5* shows the query and *Table A.6* shows the response.

Table A.5 Sample Packet for Host Query

Example	Slave Address	Function	Address High	Address Low	Data High	Data Low	CRC	
Writing loop 1 PB (20), controller 4 (single point write)	04	06	0C	1C	00	14	4B	06
Writing digital output 30 (on), controller 2 (single coil write)	02	05	0B	D5	FF	00	9F	D5

Table A.6 Sample Packet for Slave Response

Example	Slave Address	Function	Address High	Address Low	Data High	Data Low	CRC	
Writing loop 1 PB (20), controller 4 (single point write)	04	06	0C	1C	00	14	4B	06
Writing digital output 30 (on), controller 2 (single coil write)	02	05	0B	D5	FF	00	9F	D5



Appendix B: Declaration of Conformity

Declaration of Conformity
Series PPC-2000 CE

WATLOW Anafaze
314 Westridge Drive
Watsonville, California 95076 USA

Declares that the following product: **English**

Designation:	PPC-2000
Model Numbers:	PPC–2 (010, 02X*, 040, 05X*, 06X*, or 07X*), PPC-AITB, PPC-TB50 *X denotes any number 0-9
Classification:	Open Type Process Control Equipment, Installation Category II, Pollution degree II
Rated Voltage:	12 to 24 V⎓ (dc)
Rated Power Consumption:	50 VA maximum

Meets the essential requirements of the following European Union Directives by using the relevant standards show below to indicate compliance.

89/336/EEC Electromagnetic Compatibility Directive

EN 61326:1997 With A1:1998 – Electrical equipment for measurement, control and laboratory use – EMC requirements (Industrial Immunity, Class A Emissions).

Equipment is not for use in Class B emission environment without additional filtering.

EN 61000-4-2:1996 With A1, 1998 – Electrostatic Discharge Immunity
EN 61000-4-3:1997 – Radiated Field Immunity
EN 61000-4-4:1995 – Electrical Fast-Transient / Burst Immunity
EN 61000-4-5:1995 With A1, 1996 – Surge Immunity
EN 61000-4-6:1996 – Conducted Immunity
EN 61000-4-11:1994 Voltage Dips, Short Interruptions and Voltage Variations Immunity
EN 61000-3-2:1995 With A1-3:1999 – Harmonic Current Emissions
EN 61000-3-3:1995 With A1:1998 – Voltage Fluctuations and Flicker

73/23/EEC Low-Voltage Directive

EN 61010-1:1993 With A1:1995 Safety Requirements of electrical equipment for measurement, control and laboratory use. Part 1: General requirements

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déclare que le produit suivant : ***Français***

Désignation :	PPC-2000
Numéros de modèle :	PPC–2 (010, 02X*, 040, 05X*, 06X*, ou 07X*), PPC-AITB, PPC-TB50 *X remplace tout chiffre de 0 à 9
Classification :	Appareil de contrôle de procédés, Catégorie d'installation II, Degré de pollution II
Tension nominale :	12 à 24 V⎓ (c.c)

Consommation d'alimentation nominale: 50 VA maximum

Répond aux normes essentielles des directives suivantes de l'Union européenne en utilisant les standards normalisés ci-dessous qui expliquent les normes auxquelles répondre :

Directive 89/336/CEE sur la compatibilité électromagnétique

EN 61326:1997 avec A1 :1998 – Matériel électrique destiné à l'étalonnage, au contrôle et à l'utilisation en laboratoire – Exigences CEM (Immunité industrielle, Émissions de catégorie A).

Doit être équipé de filtre extérieur pour l'utilisation en classe B.

EN 61000-4-2:1996 Avec A1, 1998 – Immunité aux décharges électrostatiques
EN 61000-4-3:1997 – Immunité aux champs de radiation
EN 61000-4-4:1995 – Immunité contre les surtensions électriques rapides/ Rafale
EN 61000-4-5:1995 avec A1, 1996 – Immunité contre les surtensions
EN 61000-4-6:1996 – Immunité conduite
EN 61000-4-11:1994 Immunité contre les écarts de tension, interruptions courtes et variations de tension
EN 61000-3-2:1995 avec A1-3 :1999 – Emissions de courant harmoniques
EN 61000-3-3:1995 avec A1 :1998 – Fluctuations et vacillements de tension

Directive 73/23/CEE sur les basses tensions

EN 61010-1:1993 avec A1 :1995 Normes de sécurité du matériel électrique pour la mesure, le contrôle et l'utilisation en laboratoire. 1ère partie : Conditions générales

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Erklärt, dass das folgende Produkt: ***Deutsch***

Bezeichnung:	PPC-2000
Modell-Nummern:	PPC–2 (010, 02X*, 040, 05X*, 06X*, oder 07X*), PPC-AITB, PPC-TB50 *X anstelle einer Nummer 0 to 9
Klassifikation:	Offenes Prozessregelsystem, Installationskategorie II, Verschmutzungsgrad II
Nennspannung:	12 bis 24 V⎓ (DC)
Nennstromverbrauch:	50 VA max.

Erfüllt die wichtigsten Normen der folgenden Anweisung(en) der Europäischen Union unter Verwendung des wichtigsten Abschnitts bzw. der wichtigsten Abschnitte die unten zur Befolgung aufgezeigt werden.

89/336/EEC Elektromagnetische Kompatibilitätsrichtlinie

EN 61326:1997 mit A1:1998 – Elektrisches Gerät für Messung, Kontrolle und Laborgebrauch – EMV-Anforderungen (Störfestigkeit Industriebereich, Klasse A Emissionen)

Equipment ist nicht für die Benutzung in Klasse B Emmisionsumgebung ohne zusätzliche Filter geeignet.

EN 61000-4-2:1996 mit A1, 1998 – Störfestigkeit gegen elektronische Entladung
EN 61000-4-3:1997 – Störfestigkeit gegen Strahlungsfelder
EN 61000-4-4:1995 – Störfestigkeit gegen schnelle Stöße/Burst
EN 61000-4-5:1995 mit A1, 1996 – Störfestigkeit gegen Überspannung
EN 61000-4-6:1996 – Geleitete Störfestigkeit
EN 61000-4-11:1994 Störfestigkeit gegen Spannungsabfall, kurze Unterbrechungen und Spannungsschwankungen
EN 61000-3-2:1995 mit A1-3:1999 – Harmonische Stromemissionen
EN 61000-3-3:1995 mit A1:1998 – Spannungsfluktationen und Flimmern

73/23/EEC Niederspannungsrichtlinie

EN 61010-1:1993 mit A1:1995 Sicherheitsanforderungen für elektrische Geräte für Messungen, Kontrolle und Laborgebrauch. Teil 1: Allgemeine Anforderungen

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Declara que el producto siguiente: ***Español***

Designación:	PPC-2000
Números de modelo:	PPC–2 (010, 02X*, 040, 05X*, 06X*, o 07X*), PPC-AITB, PPC-TB50 *X representa un número de 0 a 9
Clasificación:	Equipo Para Control de Proceso de Tipo Abierto, Voltaje nominal 12 a 24 V⎓ (CD)

Consumo de energía nominal: 50 VA máximo

Cumple con los requisitos esenciales de las siguientes Directrices de la Unión Europea mediante el uso de las normas aplicables que se muestran a continuación para indicar su conformidad.

89/336/EEC Directriz de compatibilidad electromagnética

EN 61326:1997 CON A1:1998.– Equipo eléctrico para medición, control y uso en laboratorio – Requisitos EMC (Inmunidad industrial, Emisiones Clase A).

Este Equipo no debe ser utilizado en Ambientes de Emisión Clase B sin filtrado adicional.

EN 61000-4-2:1996 con A1, 1988 – Inmunidad a descarga electrostática
EN 61000-4-3:1997 – Inmunidad a campo radiado
EN 61000-4-4:1995 – Inmunidad a incremento repentino/rápidas fluctuaciones eléctricas transitorias
EN 61000-4-5:1995 con A1, 1996 – Inmunidad a picos de voltaje o corriente
EN 61000-4-6:1996 – Inmunidad por conducción
EN 61000-4-11:1994 Inmunidad a caídas de voltaje, variaciones y pequeñas interrupciones de voltaje
EN 61000-3-2:1995 con A1-3:1999 – Emisiones de corriente armónica
EN 61000-3-3:1995 con A1:1998 – Fluctuaciones de voltaje y centelleo.

73/23/EEC Directriz de bajo voltaje

EN 61010-1:1993 con A1:1995 Requisitos de seguridad de equipo eléctric para medición, control y uso en laboratorio. Parte 1: Requisitos generales

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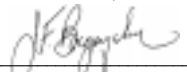
Jim Boigenzahn Name of Authorized Representative	Watsonville, California, USA Place of Issue
General Manager Title of Authorized Representative	February, 2002 Date of Issue



Signature of Authorized Representative

Doc. # 30029-00

Glossary

A

Alarm

A signal that indicates that the process has exceeded or fallen below a certain range around the setpoint. For example, an alarm may indicate that a process is too hot or too cold. See also:

- Deviation Alarm
- Failed Sensor Alarm
- Global Alarm
- High Deviation Alarm
- High Process Alarm
- Loop Alarm
- Low Deviation Alarm
- Low Process Alarm

Ambient Temperature

The temperature of the air or other medium that surrounds the components of a thermal system.

American Wire Gauge (AWG)

A standard of the dimensional characteristics of wire used to conduct electrical current or signals. AWG is identical to the Brown and Sharpe (B&S) wire gauge.

Analog input

A continuously variable signal that is generated by a process sensor and measured by a controller. It usually represents a value, such as process variable. Some analog input signals are –10 to 100 mV, 4-20 mA, 0-5Vdc

Analog Output

A continuously variable signal that is generated to control a process element, such as a heater or motor speed. Some analog output signals are 0-20 mA and 0-10Vdc.

Auto Mode

A feature that allows the controller to set PID control outputs in response to the Process Variable (PV) and the setpoint.

B

Baud Rate

The rate of information transfer in serial communications, measured in bits per second.

Boolean

A variable with a value of either 1 or 0.

C

Calibration

The comparison of a measuring device (an unknown) against an equal or better standard.

Channel

The hardware and firmware that determine the behavior of control and alarm outputs based on user set parameters and measured feedback.

Closed Loop

A control system that uses a sensor to measure a process variable and makes decisions based on that feedback.

Control Action

The response of a control output when the process variable is changed.

Control Loop

A system that affects controlled elements (outputs) either in response to process or user defined input.

Control Mode

The type of action that a controller uses. For example, On/Off, time proportioning, PID, Automatic or manual, and combinations of these.

Cool

A control method and association of parameters organized around maintaining temperature below ambient.

Current

The rate of flow of electricity. The unit of measure is the ampere (A).
1 ampere = 1 coulomb per second.

Custom Linear Input
A user-defined process input that represents a straight line function.

D

Deadband
The range through which a variation of the input produces no noticeable change in the output. In the deadband, specific conditions can be placed on control output actions. Operators select the deadband. It is usually above the heating proportional band and below the cooling proportional band.

Default Parameters
The programmed instructions that are permanently stored in the microprocessor software.

Derivative Control (D)
The last term in the PID algorithm. Action that anticipated the rate of change of the process, and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output in the same direction as the proportional error. This is caused by a change in the process variable (PV) that decreases over the time of the derivative (TD). The TD is in units of seconds.

Deviation Alarm
Warns that a process has exceeded or fallen below a certain range around the setpoint.

Digital to Analog Converter (DAC)
A device that converts a numerical input signal to a signal that is proportional to the input in some way.

Digital I/O
I/O that interfaces to 2 state field devices such limit switches or solid state relays.

DIN (Deutsche Industrial Norms)
A set of technical, scientific and dimensional standards developed in Germany. Many DIN standards have worldwide recognition.

Dip Switch
A set of compact toggle switches used to configure electronic hardware. The toggle switches are housed in a Dual In-line Package.

Distributed Zero Crossing (DZC)
A form of digital output control. Similar to burst fire.

E

Electromagnetic Interference (EMI)
Electrical and magnetic noise imposed on a system. There are many possible causes, such as switching ac power on inside the sine wave. EMI can interfere with the operation of controls and other devices.

Engineering Units
Selectable units of measure, such as degrees Celsius and Fahrenheit, pounds per square inch, Newtons per meter, gallons per minute, liters per minute, cubic feet per minute or cubic meters per minute.

EPROM
Erasable Programmable, Read-Only Memory inside the controller.

F

Failed Sensor Alarm
Warns that an input sensor no longer produces a valid signal. For example, when there are thermocouple breaks, infrared problems or resistance temperature detector (RTD) open or short failures.

Filter
Filters are used to handle various electrical noise problems.

Digital Filter (DF) — A filter that allows the response of a system when inputs change unrealistically or too fast. Equivalent to a standard resistor-capacitor (RC) filter

Digital Adaptive Filter — A filter that rejects high frequency input signal noise (noise spikes).

Heat/Cool Output Filter — A filter that slows the change in the response of the heat or cool output. The output responds to a step change by going to approximately 2/3 its final value within the numbers of scans that are set.

Flags
A program variable with a value of either 1 or 0.

Frequency
The number of cycles over a specified period of time, usually measured in cycles per second. Also referred to as Hertz (Hz). The reciprocal is called the period.

G

Gain
The amount of amplification used in an electrical circuit. Gain can also refer to the Proportional (P) mode of PID.

Global Alarm
Alarm associated with a global digital output that is cleared directly from a controller or through a user interface.

H

Heat
A control method and association of parameters organized around maintaining temperature above ambient.

Hertz(Hz)
Frequency, measured in cycles per second.

High Deviation Alarm
Warns that the process is above setpoint, but below the high process variable. It can be used as either an alarm or control function.

High Isolation
System used on some PPC-2000 analog input modules to protect electronic components from high voltage faults.

High Process Alarm
A signal that is tied to a set maximum value that can be used as either an alarm or control function.

I

Input
Process variable information that is supplied to the instrument.

Input Scaling
The ability to scale input readings (readings in percent of full scale) to the engineering units of the process variable.

Input Type
The signal type that is connected to an input, such as thermocouple, RTD, linear or process.

Integer
A variable with a potential range of –32,768 to 32,767.

Integral Control (I)
Control action that automatically eliminates off-set, or droop, between setpoint and actual process temperature.

J

Jumper
A removeable connector that acts as a switch between a set of pins on a circuit board used to configure electronic hardware.

L

Linear Input
A process input that represents a straight line function.

Low Deviation Alarm
Warns that the process is below the setpoint, but above the low process variable. It can be used as either an alarm or control function.

Low Process Alarm
A signal that is tied to a set minimum value that can be used as either an alarm or control function.

M

Manual Mode
A selectable mode that has no automatic control aspects. The operator sets output levels.

Modbus
Industrial communications protocol developed by AEG Schneider Automation.

Modbus Address
Number that specifies a bit or word register within a controller's memory.

Modbus Database Offset
A number which is combined with a parameter's first address to locate specific Modbus addresses.

Module
A component of a PPC-2000 system which attaches and interfaces with other components.

Module I/O Number
Number designating each I/O supported on a module. For example, a PPC-2021 has 16 analog inputs; each input on the module has a unique designation from 1 to 16.

O

Offset
The difference in temperature between the setpoint and the actual process temperature. Offset is the error in the process variable that is typical of proportional-only control.

Output
Control signal action in response to the difference between setpoint and process variable.

Output Type
The form of PID control output, such as Time Proportioning, Distributed Zero Crossing, SDAC, or Analog. Also the description of the electrical hardware that makes up the output.

P

Parameters
The programmed instructions and readings that are stored in a microprocessor software.

Parity
A communications error checking method in which the quantity of bits in each byte is determined to be odd or even. If there is a discrepancy between the transmitter and receiver, a communications error has occurred.

PID
Proportional, Integral, Derivative. A control mode with three functions: Proportional action dampens the system response, Integral corrects for droops, and Derivative prevents overshoot and undershoot.

Pin Number
Generic terminal block identification numbers which are correlated to module I/O numbers in terminal block identification tables for wiring.

Polarity
The electrical quality of having two opposite poles, one positive and one negative. Polarity determines the direction in which a current tends to flow.

Process Variable
The parameter that is controlled or measured. Typical examples are temperature, relative humidity, pressure, flow, fluid level, events, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

Proportional (P)
Output effort proportional to the error from setpoint. For example, if the proportional band is 20^{o} and the process is 10^{o} below the setpoint, the heat proportioned effort is 50%. The lower the PB value, the higher the gain.

Proportional Band (PB)
A range in which the proportioning function of the control is active. Expressed in units, degrees or percent of span.
See PID.

Proportional Control
A control using only the P (proportional) value of PID control.

Protocol
A set of rules and formats governing a serial or parallel communication channel.

Pulse Input
Digital pulse signals from devices, such as optical encoders.

R

Range
The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

Register
A controller memory location. Registers are either bit or word values.

Relay
A switching device.

Electromechanical Relay — A power switching device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other. Not recommended for PID control.

Solid State Relay (SSR) — A switching device with no moving parts that completes or interrupts a circuit electrically.

Reset
Control action that automatically eliminates offset or droop between setpoint and actual process temperature.
See also Integral.

Automatic Reset — The integral function of a PI or PID temperature controller that adjusts the process temperature to the setpoint after the system stabilizes. The inverse of integral.

RTD (Resistance Temperature Detector/Device)
A sensor that uses the resistance temperature characteristic to measure temperature. There are two basic types of RTDs: the wire RTD, which is usually made of platinum, and the thermistor which is made of a semiconductor material. The wire RTD is a positive temperature coefficient sensor only, while the thermistor can have either a negative or positive temperature coefficient.

S

Serial Communications
A method of transmitting information between devices by sending all bits serially over a single communication channel.

RS-232—An Electronics Industries of America (EIA) standard for interface between data terminal equipment and data communications equipment for serial binary data interchange. This is usually for communications over a short distance (50 feet or less) and to a single device.

RS-485—An Electronics Industries of America (EIA) standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems. This is usually used to communicate with multiple devices over a common cable or where distances over 50 feet are required.

Setpoint (SP)
The desired value programmed into a controller. For example, the temperature at which a system is to be maintained.

Soft Bool
A generic Boolean variable which is stored in the PPC-2000 database and is accessible by AnaWin or a logic program. Values range from 1 to 0 (true or false).

Soft Int
A generic integer variable which is stored in the PPC-2000 database and is accessible by AnaWin or a logic program. Values are –32,768 to 32,767.

Spread
In heat/cool applications, the +/- difference between heat and cool. Also known as process deadband.

Switch
Dip
A set of compact toggle switches used to configure electronic hardware. The toggle switches are housed in a Dual In-line Package.

Rotary
A switch with multiple dial-in settings used to configure electronic hardware.

T

Thermistor

A temperature-sensing device made of semiconductor material that exhibits a large change in resistance for a small change in temperature. Thermistors usually have negative temperature coefficients, although they are also available with positive temperature coefficients.

Thermocouple (T/C)

A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

Tune

To set PID parameters on a closed-loop control system.

V

Volt (V)

The unit of measure for electrical potential, voltage or electromotive force (EMF).

Voltage (V)

The difference in electrical potential between two points in a circuit. It's the push or pressure behind current flow through a circuit. One volt (V) is the difference in potential required to move one coulomb of charge between two points in a circuit, consuming one joule of energy. In other words, one volt (V) is equal to one ampere of current (I) flowing through one ohm of resistance (R), or V=IR.